Juniper Engines Inc.

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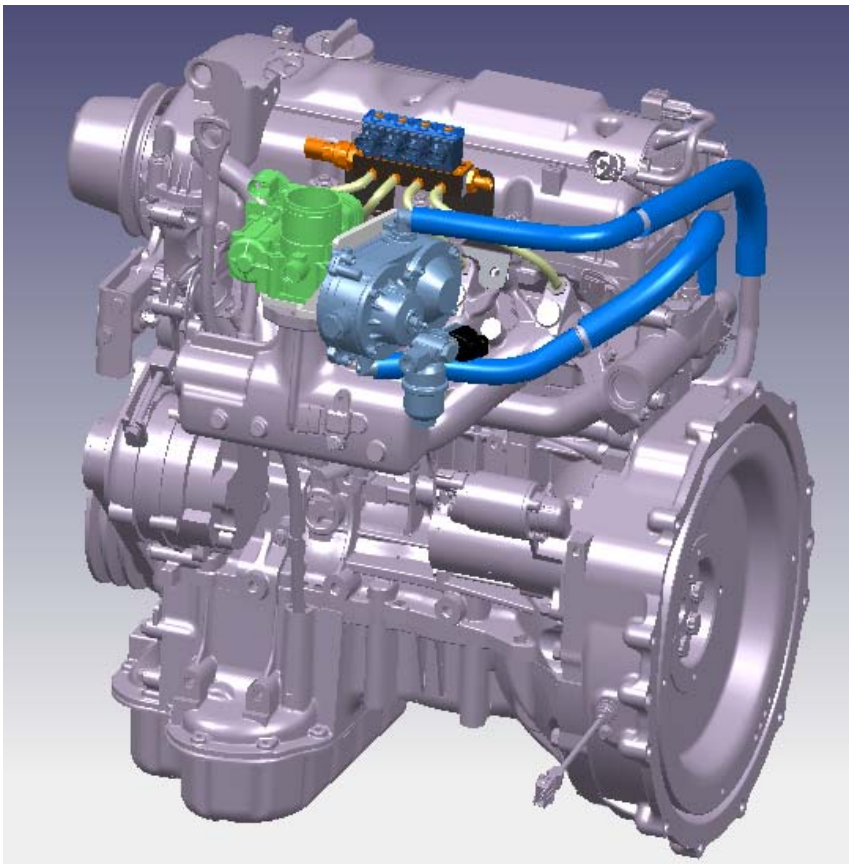
JUNIPER 2.4L LPG ENGINE & FUEL SYSTEM SERVICE MANUAL



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GENERAL WARNINGS

Maintenance of the engine and/or fuel system does not need to be performed by Juniper personnel in order to maintain warranty coverage, but must be carried out be qualified personnel.

It is important to read this manual in its entirety in order to fully understand the fuel system operation and maintenance requirements prior to performing maintenance work. It is the equipment owner's responsibility to maintain the engine and fuel system as per these instructions.

Failure to follow these instructions could lead to personnel injury or property/equipment damage.

This engine and fuel system are certified to EPA 2007 and CARB 2010 emissions regulations. Failure to follow these maintenance instructions could lead to premature failure of the emissions critical components or could otherwise lead to the emissions of the equipment being out of compliance.

1. INTRODUCTION

1.1 OVERVIEW

Juniper's fuel system is designed to provide a complete, fully integrated LPG engine solution that will meet the strictest emission standards for large, spark-ignited industrial engines in North America.

The advanced sequential multi-point system injects gaseous LPG into the intake ports. The fuel injectors are microprocessor controlled and the injector pulse-width is based on a speed/density algorithm.

Closed loop fuelling control uses a standard narrowband oxygen sensor to maintain a stoichiometric fuel mixture and adjust adaptive learning parameters as the system ages. Regulatory exhaust emissions are achieved by use of a three-way catalyst (TWC).

The engine ECU includes basic diagnostic features as required by the EPA as well as diagnostic checks for each engine sensor and a malfunction indication light (MIL) system which can be incorporated into the vehicle dashboard. Communication with the ECU is through a laptop service tool utilizing CAN bus protocol and a dedicated interface control tool.

The complete engine and fuel system are primarily designed to be used in Class 4 and Class 5 forklift applications but may be used in other industrial applications

where applicable. Juniper's engine installation requirements must be adhered to at all times in order to ensure safe and reliable operation that meets the regulatory emissions requirements.

1.2 EPA/CARB Emissions Certification

When properly applied and calibrated Juniper's LPG engine control system is capable of meeting EPA 2007 LSI (40 CFR Part 1048.101) and CARB 2010 emissions standards, when operating properly with an approved three-way catalyst. The emission standards, including appropriate deterioration factors over the useful life of the system, are as follows:

HC+NOx: 0.8 g/kW-hr
CO: 20.6 g/kW-hr

As defined in the applicable regulations, the engine control system is designed to maintain emissions compliance for seven (7) years or 5000 hours, whichever occurs first, provided appropriate maintenance is performed as defined in the service manual for the system. Component warranty shall comply with regulatory requirements (40 CFR Part 1048.120) for all emission related components. Warranty for non-critical emissions components will be as defined in the individual purchase agreement.

2. BASE ENGINE DESCRIPTION

The Juniper system is based on the Hyundai 2.4L base spark-ignited engine. The automotive gasoline version of this engine has been in production since 2000 and the LPG automotive version since 2006. The engine is manufactured in Asan, South Korea.

There is a separate base engine service manual which provides details on engine service and repair.

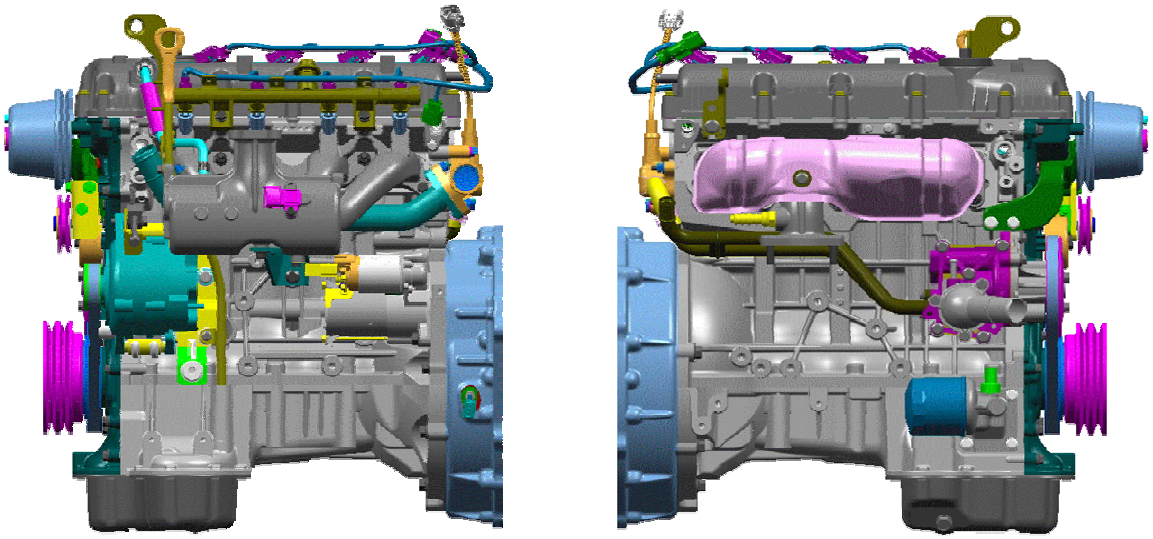


Figure 1: Hyundai 2.4L Base Engine

The general engine specifications are as follows:

General Specification of HMC 2.4L LPG Industrial Engine		
DISPLACEMENT(cc)		2,359
BORE × STROKE (MM)		88.0×97.0
CYLINDER BORE PITCH (MM)		96
ENGINE SIZE (mm)	LENGTH	673
	WIDTH	605
	HEIGHT	654
WEIGHT (kg)	DRY	146.8
CYCLE		4
COOLING TYPE		WATER
THERMOSTAT		Wax type 82°→95°
FUEL SYSTEMS ALLOWED		LPG / GASOLINE / CNG
CAM SHAFT, VALVES		DOHC - 4 VALVES/CYLINDER
VALVE CLEARANCE ADJUSTMENT		MECHANICAL
CYLINDER NUMBER		4
CYLINDER ARRANGEMENT		IN LINE
FIRING ORDER		1-3-4-2
COMPRESSION RATIO		10.5
VALVE TIMING(open/close)	INTAKE VALVE	5° BTDC / 39° ABDC
	EXHAUST VALVE	42° BBDC / 6° ATDC
VALVE LIFT(1N/EX)		7.9mm / 8.6mm
SPARK PLUGS		Pt (0.8mm)
ASPIRATION		NATURAL
COMBUSTION CHAMBER TYPE		PENT ROOF
ENGINE.OIL (Liter) - Engine only		5.7 (total engine oil)
OIL FILTRATON AREA		1060 cm^2
RECOMMENDED OIL		GF3 & SL or above, SAE 5W-20
RECOMMENDED FUEL		HD-5 or HD-10 Equivalent
COOLING WATER (Liters) - Engine only		2.2
COOLING FAN	HEIGHT (from crank pulley)	320mm
	REV. RATIO (crank:fan)	1:1.1
	BELT LENGTH (V-belt)	mm
DRIVE BELT LENGTH (V-ribbed belt)		mm
IDLE RPM		650 - 700
GOVERNED RPM		2600 -2800
ALTERNATOR		13.5V-70A
STARTER		12V-1.4kW
TIMING TRAIN		Chain
CYLINDER BLOCK MATERIAL		Aluminum
HEAD & INTAKE MANIFOLD		Aluminum

Figure 2: Base Engine Specifications

3. JUNIPER LPG FUEL SYSTEM

3.1 System Overview

The fuel system, engine components and other design features that affect emissions are summarized as follows:

- LPG vaporizer and pressure regulator
- LPG fuel rail and injectors
- Liquid LPG shutoff valve and filter
- Engine and fuel system sensors
- Intake and exhaust valve timing
- Intake and exhaust manifold design
- Air filter and intake piping
- Throttle body
- Emissions catalytic converter
- Engine Control Unit (ECU) software and calibration
- COP ignition system

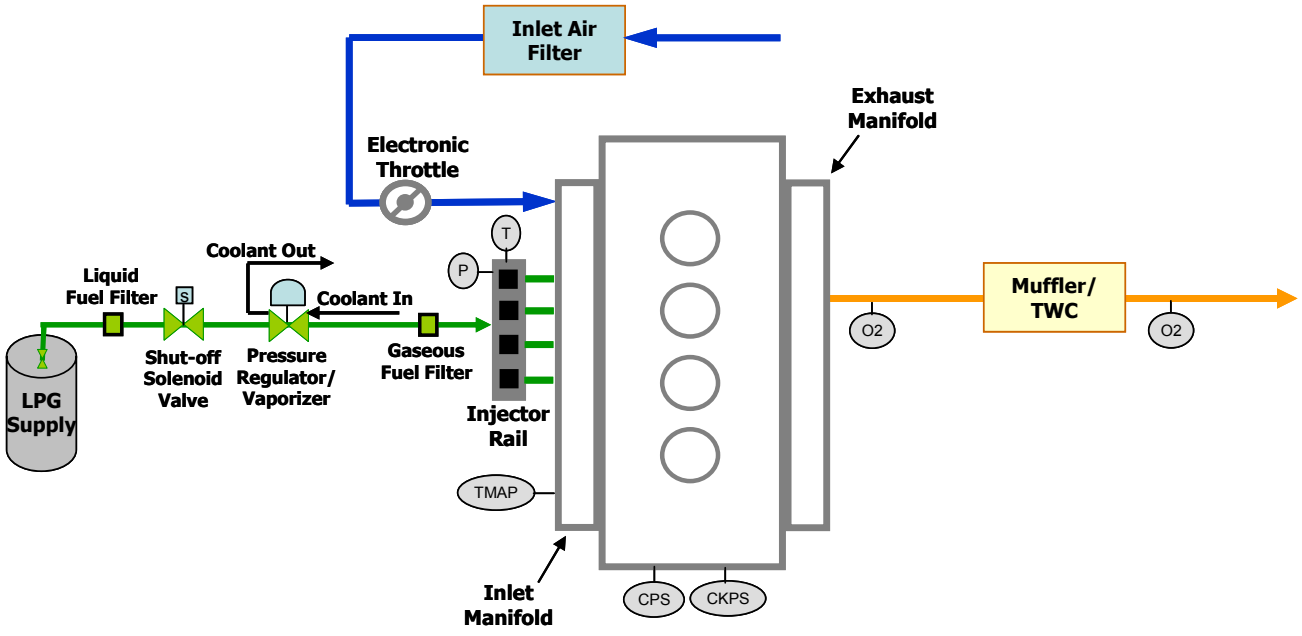


Figure 3: LPG Fuel System Schematic

3.2 System Features

The Juniper fuel system uses a speed-density control strategy for controlling fuel flow, spark timing, and throttle position. Key control features include the following:

- Closed-loop fuel control
- Speed-density spark control with tables for dwell and timing
- Speed-alpha throttle control with table for maximum throttle limiting
- Closed-loop fuel control with two oxygen sensors (one installed pre-catalyst and one installed post catalyst). The pre-catalyst oxygen sensor includes adaptive learning to compensate for fuel or component drift. The post-catalyst oxygen sensor detects the functional level of the catalyst and will set off the MIL if the catalyst is no longer performing to specification. The pre-catalyst oxygen sensor function includes parameters for rich/lean dithering amplitude and rate based on engine speed and load. Note: the non-certified engine does not have a post-catalyst oxygen sensor.
- LPG fuel temperature & pressure compensation
- Min/max speed governing
- Transient fuel enrichment based on rate of change of target throttle position
- Input sensor selection and calibration
- ECU auxiliary inputs available for MIL, vehicle speed limiting, etc.
- CAN Bus service tool interface and data transfer

Additional Features:

Tamper-Resistance – The fuel system is essentially tamper proof, in that it would be difficult for an operator to adjust the performance or emissions capability of the system without access to ECU calibration codes and calibration tools. Access to the regulator diaphragm to install a new diaphragm kit is necessary for maintenance purposes. There are no settings or adjustments possible on the fuel rail or injectors or on any other components that could affect performance or emissions.

Diagnostics – The ECU OBD system is capable of monitoring and diagnosing problems and faults within the control system. These include all sensor input hardware, control output hardware and control functions such as closed-loop fuel control limits and adaptive learn limits. Upon detecting a fault condition the system notifies the operator by illuminating the MIL and activating the appropriate fault action. The action required by each fault is set in the software and is programmable by Juniper to provide a custom product to each OEM customer as desired. Diagnostic information can be communicated through both the service tool interface and the MIL lamp. With the MIL lamp it is possible to generate a string of flashing codes that correspond to the fault identifier. These diagnostics are generated only when the engine is not running and the operator initiates a diagnostic request sequence.

Limp Home Mode - The system is capable of "limp-home" mode in the event of particular faults or failures in the system, as programmed into the OBD software. In limp-home mode the engine speed is approximately 1000 rpm at no load. A variety of fault conditions can initiate limp-home mode. These fault conditions and resulting actions are determined during system software and can be customized to meet specific

customer requirements. The OBD summary with default settings can be found in the OBD document.

Service Tool - A system service tool is available to monitor system operation and assist in diagnosis of system faults. This device monitors all sensor inputs, control outputs, and diagnostic functions in sufficient detail through a single access point to the ECU to allow a qualified service technician to maintain the system. The Service tool is operated through a lap-top computer and is connected through a USB port by use of an interface tool.

4. Fuel System Component Details

LPG Pressure Regulator/Vaporizer

The LPG pressure regulator/vaporizer ("regulator") is designed and manufactured by OMVL SpA in Italy.

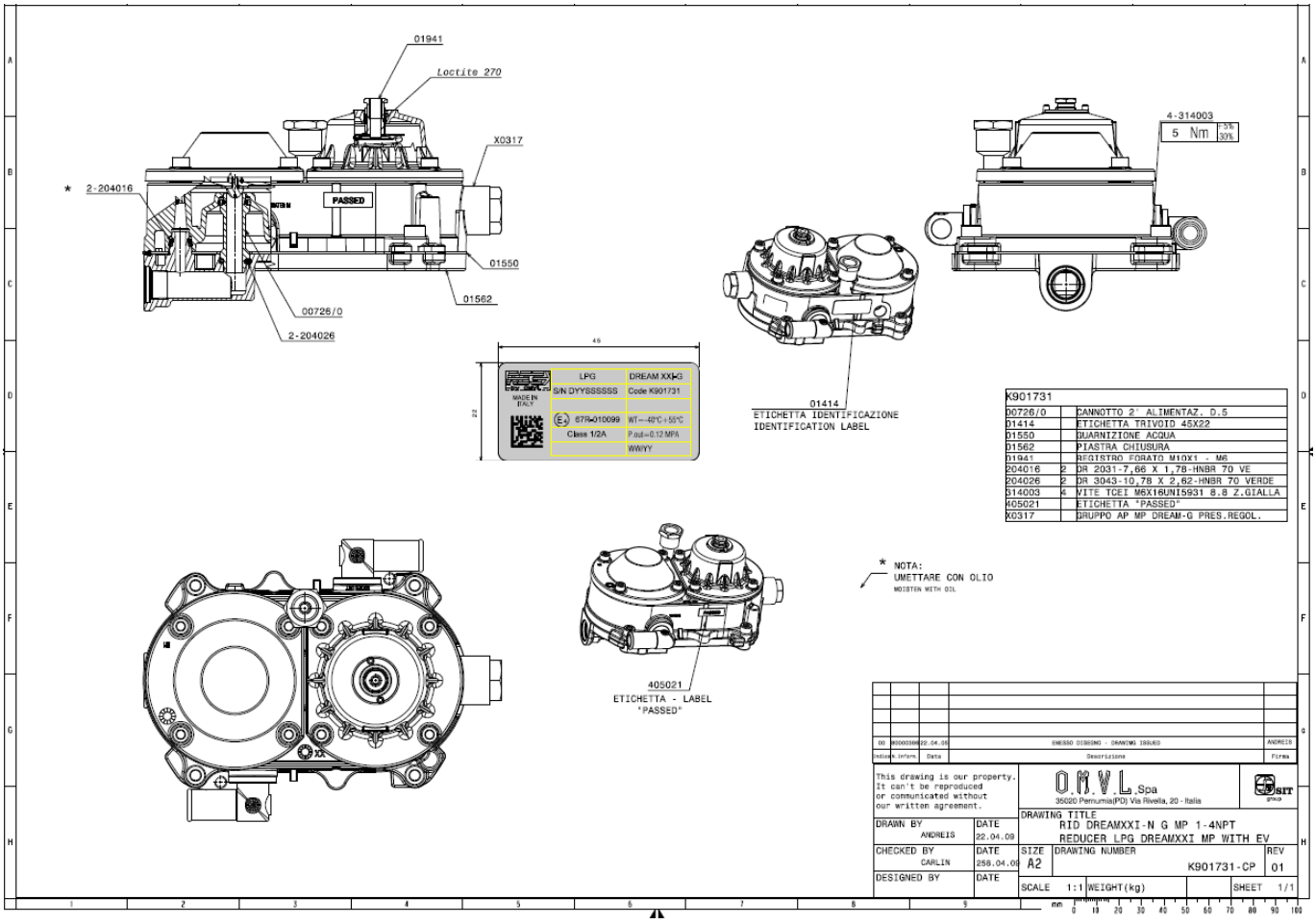


Figure 4: LPG Regulator/Vaporizer

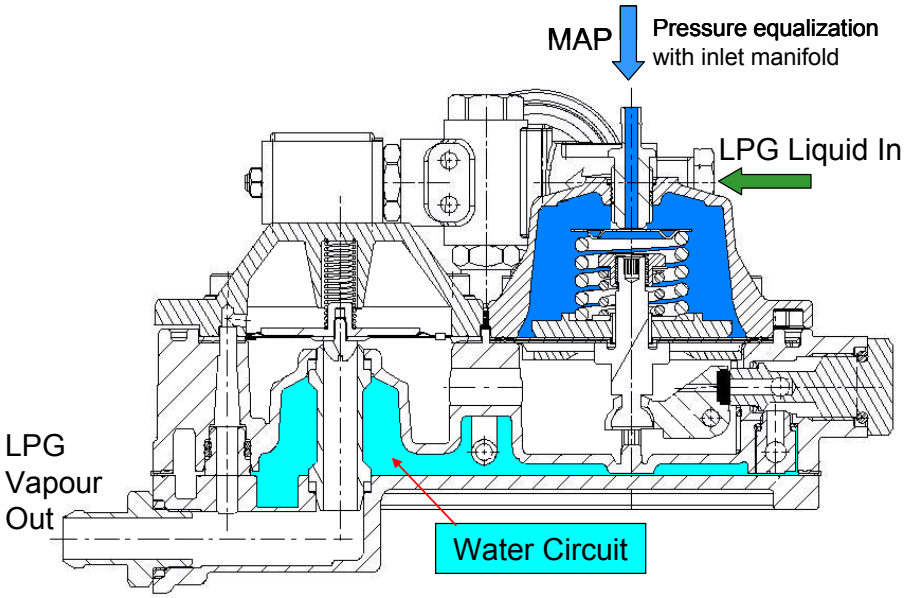
The pressure regulator receives liquid LPG from the vehicle tank, vaporizes it and feeds the gas to the injectors.

The two-stage regulator has an inlet pressure allowable range of 300 – 3000 kPa. The regulator has an adjustable outlet pressure setting that is pre-set in the factory. The nominal outlet pressure of the regulator is 120 kPa relative to the reference manifold pressure and can be adjusted to settings ranging from 110 kPa to 130 kPa. The ECU is capable of compensating for outlet pressure within this range and so the setting of regulator outlet pressure does not critically affect air/fuel ratio or exhaust emissions.

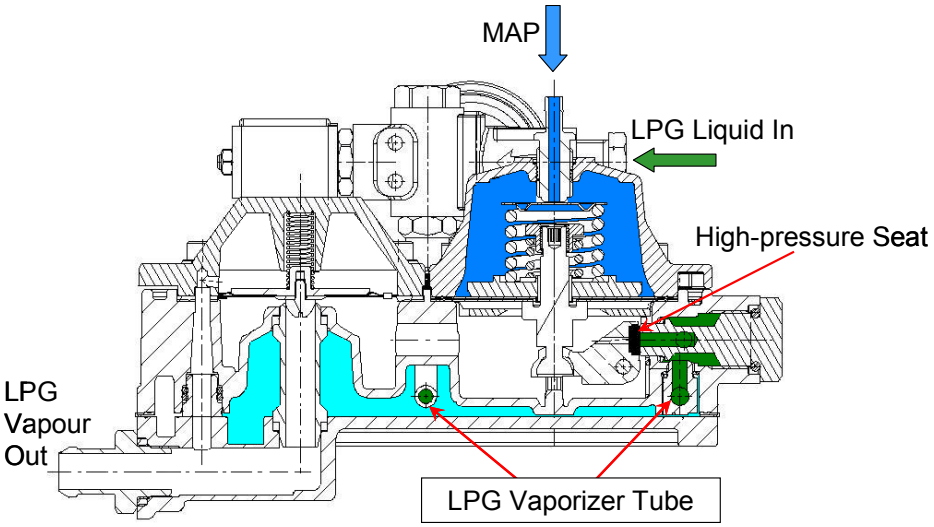
Technical Specifications:

- Working temperature: -30 - 120 °C
- Input pressure: 300 - 3000 kPa
- Input Connection: ¼" NPT
- Gas outlet pressure: 120 ± 10% kPa
- Output Connection : D14 mm
- Maximum flow rate (propane @ 300 KPa): 25 kg/h
- Pressure relief valve operating pressure: < 202 kPa
- Weight: 1.6 kg
- Durability: 2500 - 5000 hr (fuel quality dependant)
- Homologation: ECE67R-01 0099 Class 1/2A, ECE10R-02 0268, UL1337

Description of Regulator/Vaporizer Operating States:

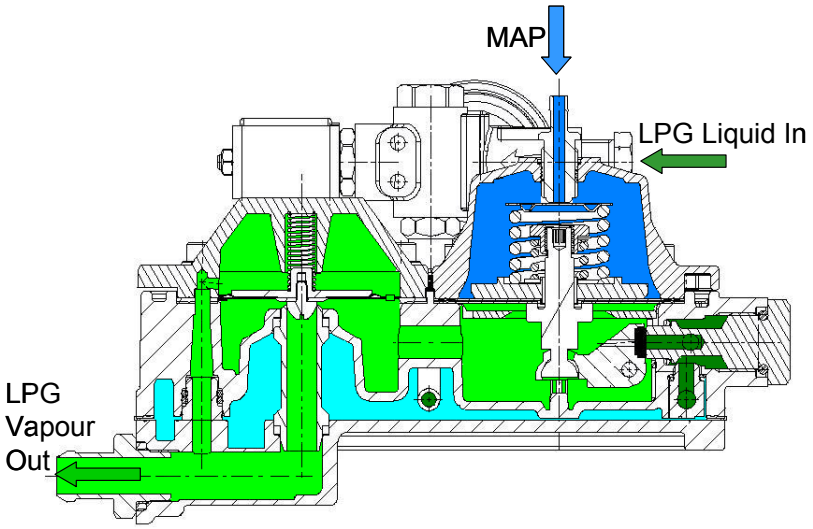


State 1: LPG Liquid Shutoff Valve Closed



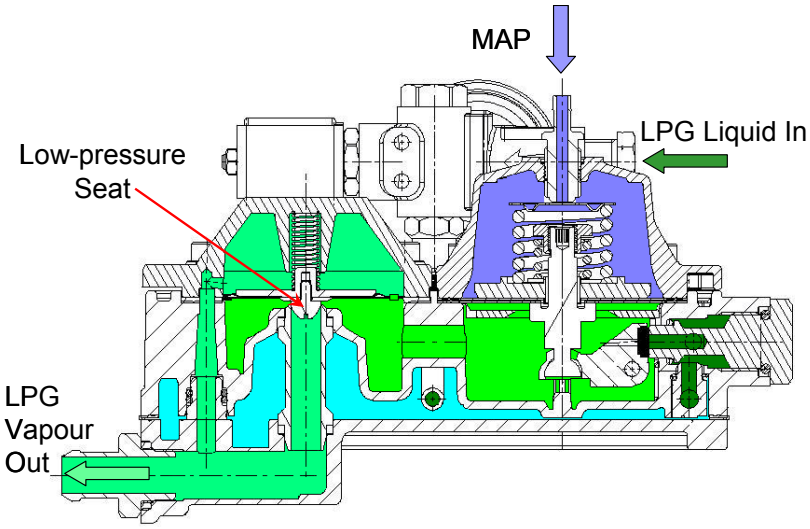
State 2: LPG Shutoff Valve Open – Engine Not Running 1

When the shut off valve is opened liquid LPG passes through the vaporizer pipe and through the pressure diaphragm. The reduction in pressure vaporizes the LPG. Circulating hot water provides the heat required to increase the maximum vaporization rate and to prevent freezing of the vaporizer.



State 3: LPG Shutoff Valve Open – Engine Not Running 2

Once the liquid starts to flow and vaporize the gas the system immediately achieves equilibrium. The resultant gas output pressure is a function of the manifold pressure and the spring setting.



State 4: Shutoff Valve Open and Engine Running

Once the engine starts and is running there is a flow of gas through the injectors reducing the pressure after the second stage reducer. Therefore the pressure on top of the membrane is lower and the membrane moves up. Gas will then flow through the low pressure seat to maintain the intended pressure.

Figure 5: Description of Regulator/Vaporizer Operating States

Liquid-Phase Filter & Shutoff Valve

The LPG pressure regulator has an integrated liquid-phase filtering unit, manufactured by Valtek that filters oil and dirt, as well as an integrated shutoff solenoid valve, compliant to ECE67R-01 “safety-car” feature. Alternatively, your system may have a close-coupled shut-off valve and filter, manufactured by AFC, which is connected to the regulator inlet by a short pipe nipple.

Filter & Shutoff Valve – **Option 1, Valtek**:

- Manufactured by Valtek
- 12 VDC, 11 W

Filtering element:

- Paper cartridge, Type 92, Buxusfilter 100/33 (serviceable)
- Design registration: ECE 67 Class 3
- Minimum filtering size: 7 µm
- Efficiency: 90%
- Filtering surface: 18,840 mm^2
- Cartridge durability: 500 hrs

Figure 6: Disassembled Liquid-phase Filter

Filter & Shutoff Valve – **Option 2, Advance Fuel Components (AFC)**:

- Manufactured by AFC
- 12Vdc, 12 Watts

Filtering element:

- Resin-impregnated cellulose element
- 40 micron nominal
- 98% filtering efficiency

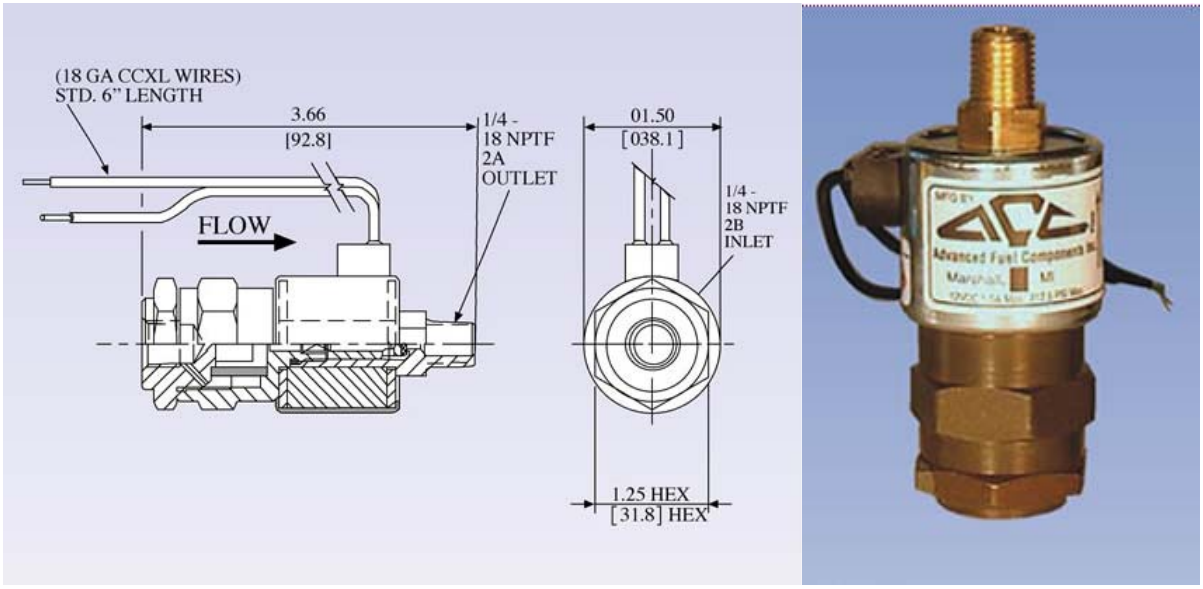


Figure 7: Alternate Liquid-phase Filter & Shutoff Valve

Fuel Rail

The fuel rail is designed and manufactured by OMVL SpA. The rail includes the fuel supply manifold, four fuel injectors, four injector solenoids, fuel supply outlet nozzles and a pressure/temperature sensor. The fuel rail is mounted on the top or beside the engine near the intake manifold. Individual hoses from each nozzle connect the rail to the inlet manifold, immediately upstream of the inlet valve for each cylinder. Fuel rail characteristics are as follows:

- Coil resistance (at 20°C): 2.9 - 3.4 Ohms
- Interface: IP54, Tyco SuperSeal 2-way connectors
- Opening time (driven at 13.5 Vdc, gas @ 200KPa, 20°C): 2.7 ms
- Speed-up current (for 3.24 ms at 13.5 Vdc, gas @ 200 kPa, 20°C): 1.8A
- Hold current (driven at 11 kHz, 13.5 Vdc, gas @ 200 kPa, 20°C): 1A
- Static flow rate per injector (air at 200 kPa, 20°C, 2.5 mm nozzle): 2.47g/s ± 5%
- Max working pressure: 600 kPa
- Burst pressure: 1000 kPa
- Working temperature: -40 - 120°C
- Sensor: integrated Sensata pressure & temperature
- Homologations: ECE110-00 0035 03, ECE67R-01 010100 03, ECE10R-02 4008 00, UL558
- Weight: 0.55 kg
- Durability: over 500 million cycles

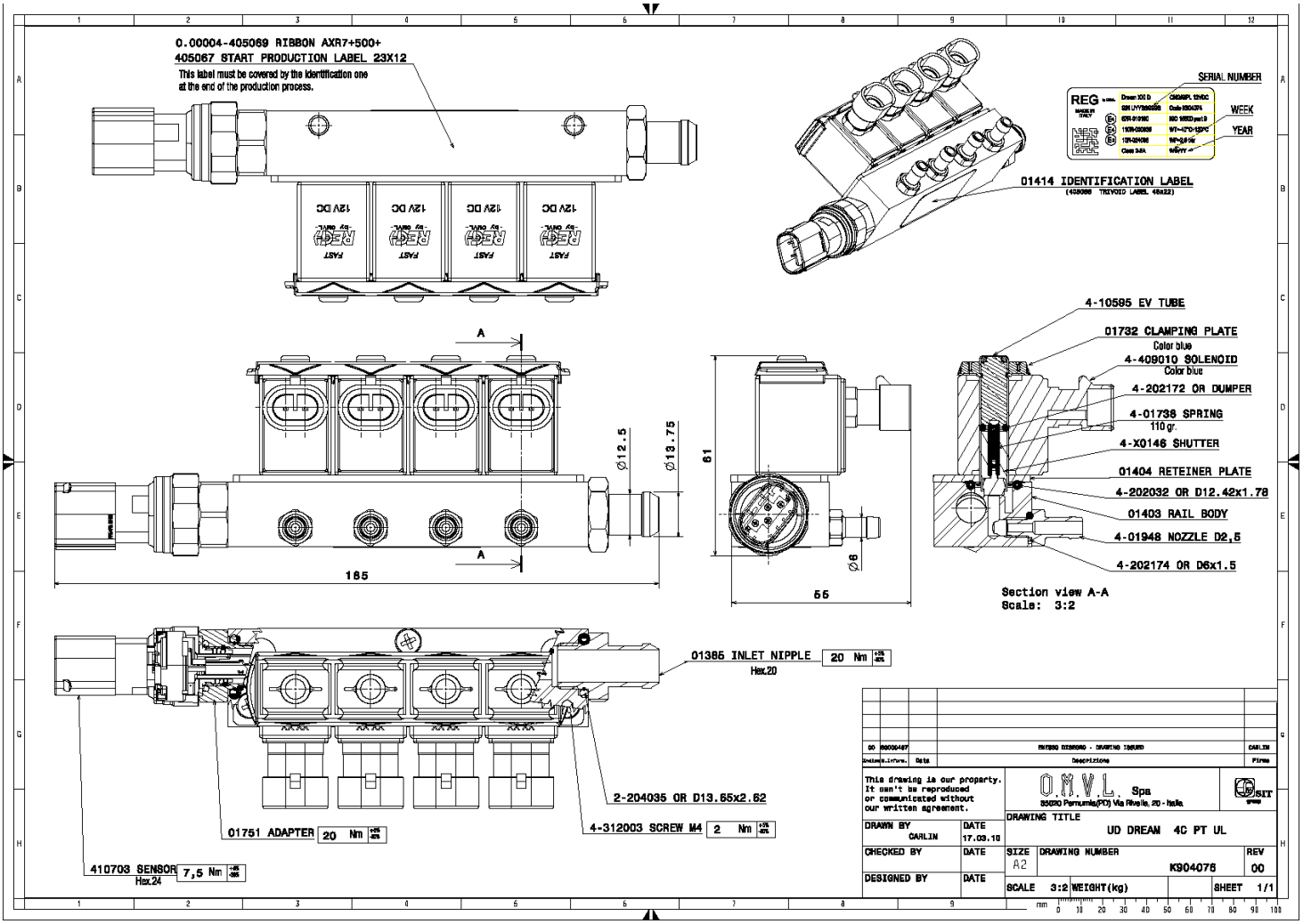


Figure 8: MPI Fuel Rail

Gaseous Fuel Filter

The fuel filter is used to remove small particles and liquids from the LPG vapor. The filter is installed between the vaporizer and the fuel rail. The filter specifications are as follows:

- LPG/CNG gaseous phase filter, class #2
- Flow rate: 55Kg/hr (air) @ 160KPa
- Max working pressure: 450 KPa (compliant to ECE110, class #2)
- Burst pressure: > 7000KPa
- Temperature range: -40-120°C (compliant to ECE110)
- Material: zinc plated steel, FeP04 (UNI5866-66)
- Filtering element:

- Paper cartridge (un-serviceable)
    - Minimum filtering size: 7µm
    - Filtering surface: 327cm2
    - Particle filtration efficiency:
    - Particles smaller than 3µm: 30-50%
    - Particles bigger than 3µm, smaller than 30µm: 85-98%
    - Particles bigger than 30µm: 98%
- Durability: dependant on fuel quality
- Homologations: ECE110R-000041, ECE67R-010105

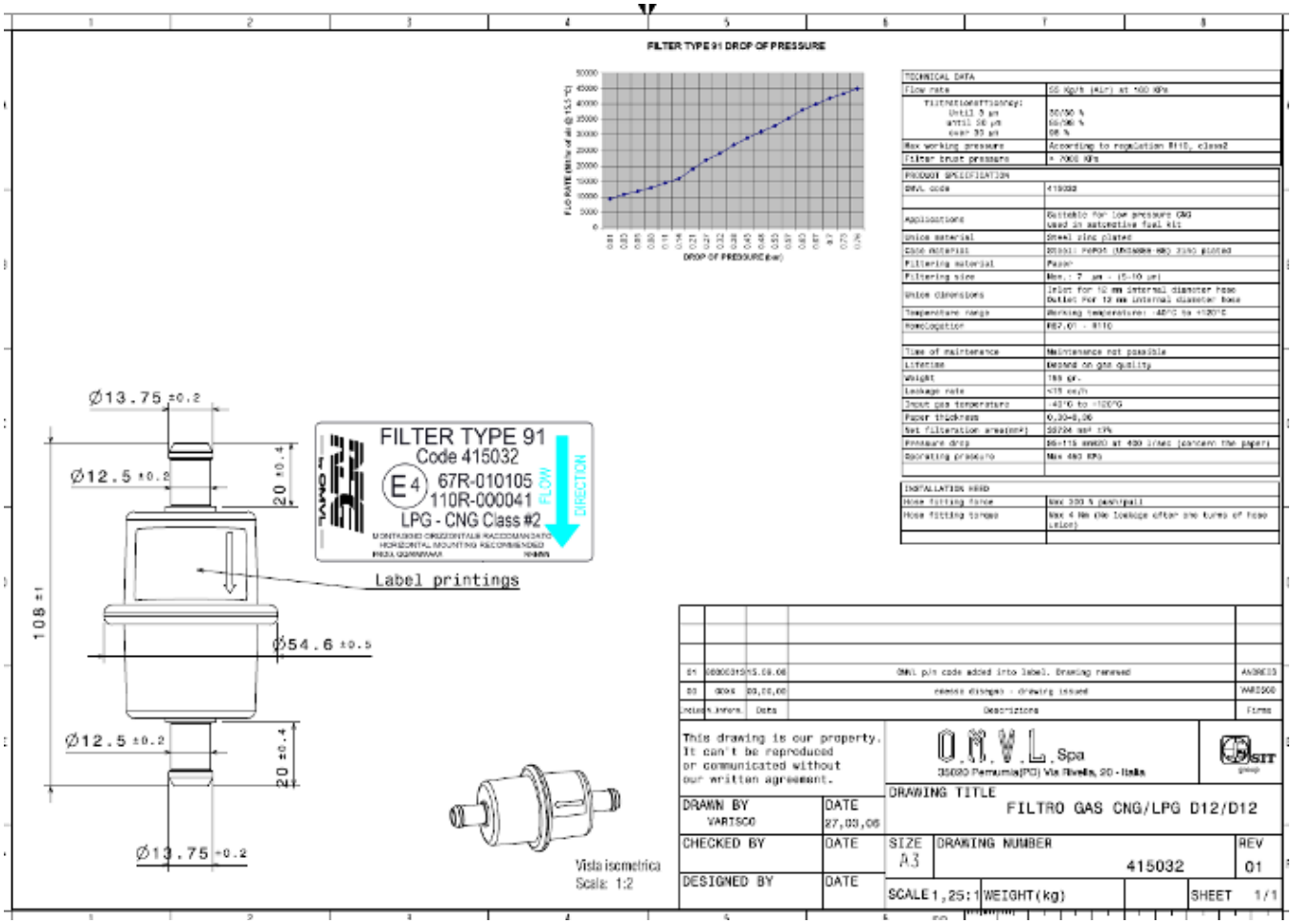


Figure 9: Gaseous Fuel Filter

Engine Control Unit

The Juniper mono-fuel Engine Control Unit (ECU) is a micro-controller based module that is capable of controlling a spark-ignited internal combustion engine with up to four cylinders. The Juniper UCU has control algorithms to achieve:

- Maximum torque
- Desired drivability:
  - speed governing, within the whole range of accepted load
  - no stalling at idle speed, within the whole range of accepted load
  - transient management
- CARB 2010 compliant emissions
- Key Word Protocol 2000 CAN-bus On-Board Diagnostics for off-road applications.
- Safety features compliant to R67, R110 and basic safety for Drive-By-Wire chain, such as:
  - de-power all gas shut-off valves within 5 seconds from engine stall
  - Inhibit gas shut-off valves, in case of electric fault
  - Inhibit outputs while the system is powered off
  - No uncontrolled driving of the throttle body in any condition

Gas fuelling is controlled by a speed density model; the ECU drives four ignition coils, the drive-by-wire chain (foot pedal position sensors, electronic throttle body, throttle-position sensors), gas shut-off solenoid valves as well as application-specific loads.

The ECU implements algorithms for cranking, warm-up, closed-loop injection control, drivability in transients, speed governing, rpm limiting and specified safety features.

Those algorithms are controlled by a set of parameters, stored into ECU memory; the parameters can be modified using a dedicated calibration software (PC-based).

The Juniper mono-fuel ECU has on-board diagnostics that monitor and detect:

- electric failures or malfunctions of all input sensors
- electric failures or malfunctions of all output actuators
- electric failures of most wiring connections
- most electric failures of ECU itself
- fault conditions that negatively impact emissions

The specified on-board diagnostics are compliant with:

- SAE J 1979: E/E Diagnostic test modes.
- ISO 14230-4 Keyword Protocol 2000, Part 4: Requirements for emission-related systems.
- Proprietary KWP2000 ISO14230 protocol over CAN-bus protocol.

ECU Key features:

Micro-controller	• Hitachi 32 bit, 80MHz • MB flash memory • 48 kB SRAM
Inputs	• Foot-pedal position sensors • Throttle position sensors • Intake air temperature sensor • Manifold air pressure sensor • CAM shaft position sensor • Crank shaft angle sensor • Engine coolant temperature sensor • Oil pressure switch • Pre-cat and post-cat oxygen sensors • Gas temperature sensor • Gas pressure sensor • Vehicle speed sensor input • 2 spare inputs (speed selection control)
Optional inputs	• Pressure reducer temperature sensor • Level sensor in multi-valve or high pressure sensor • Knock sensor
Outputs	• High-pressure solenoid valve • 4 gas injectors • 4 ignition coils • Throttle body control • 2 oxygen sensors heater PWM outputs • Check-engine lamp output (MIL) • Load relay output • 2 spare 5V analog PWM output (fuel and temperature gauges…) • 2 spare 12V PWM outputs (relays, speed gauge)
Optional outputs	• Oil pressure warning lamp output • Tank shutoff solenoid valve in multi-valve • Low pressure solenoid valve • Instrumentation (hour counter)
Communication lines	• Diagnostic CAN line (KW2000) • Internal calibration CAN line

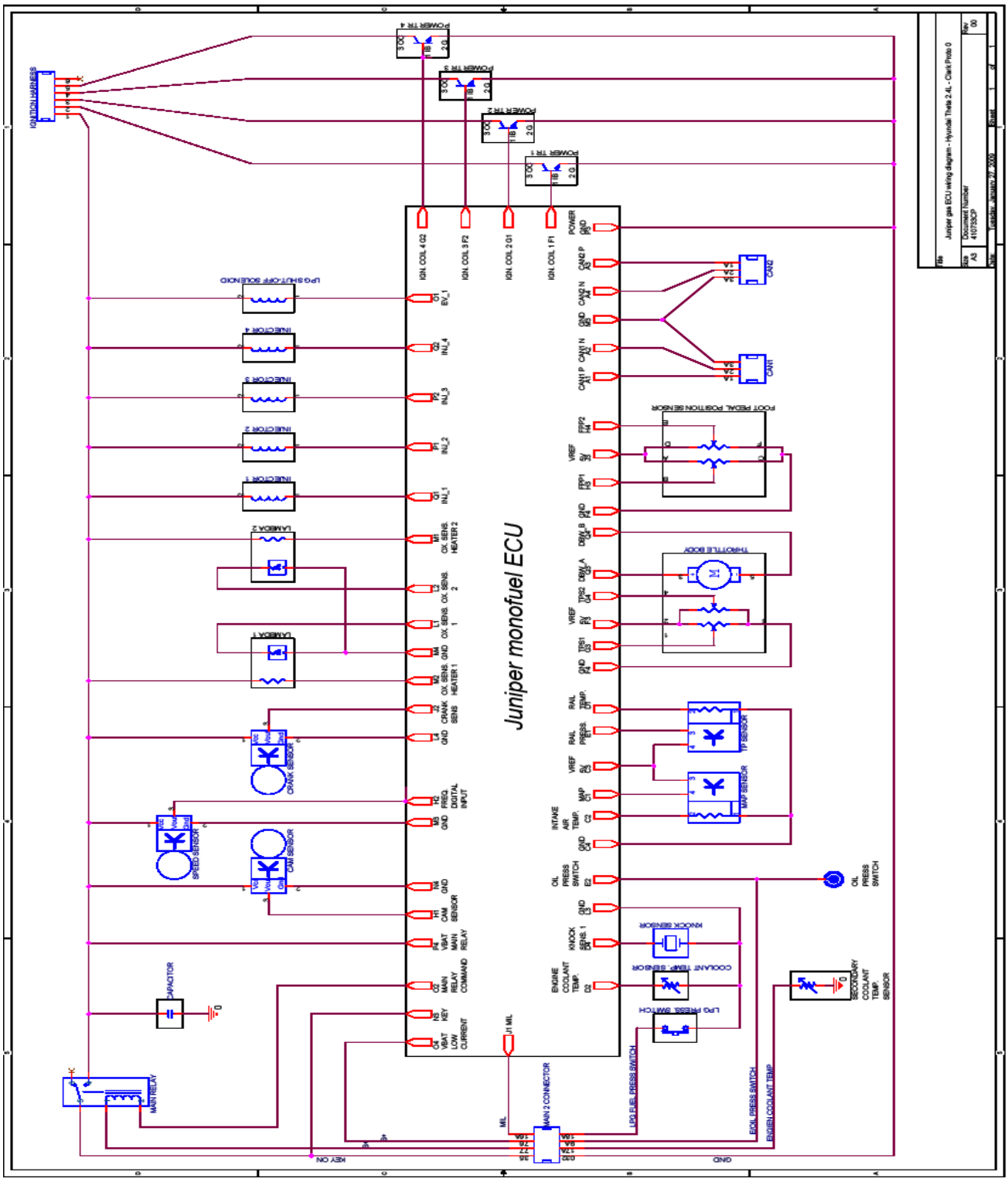


Figure 10: Juniper Engine Control Schematic

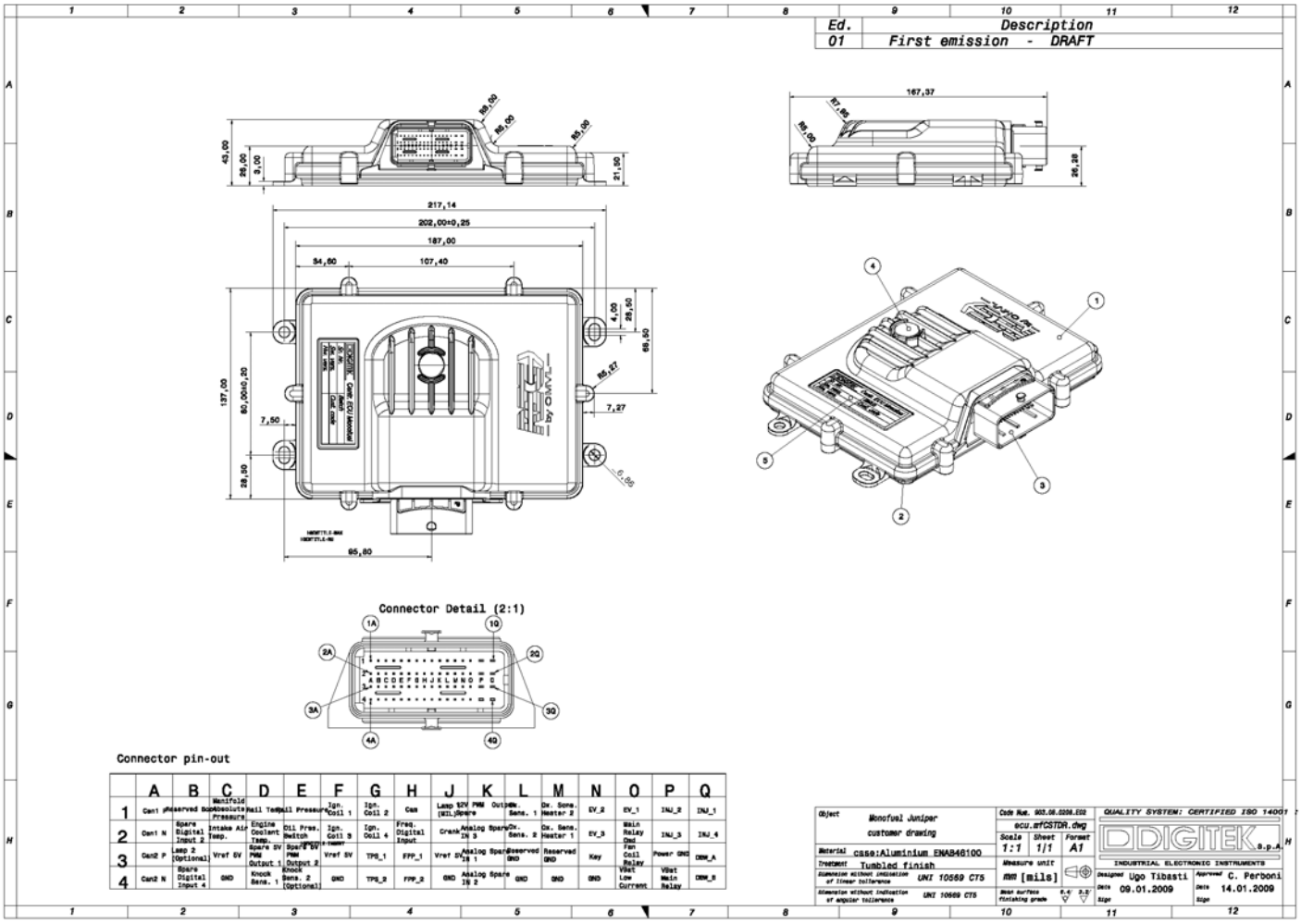


Figure 11: Juniper Engine Control Unit

Wire Harness

Juniper is providing a wire harness to connect the ECU to the various sensors and control devices. The harness also connects to customer supplied sensors, the dash-board display and the vehicle battery.

Two distinct harnesses will be supplied – one for the USA market and one for trucks shipped outside of the USA. The difference is due to the requirements for a post-catalyst oxygen sensor for the EPA certified engines. The wire harness schematic is shown in Figure 12.

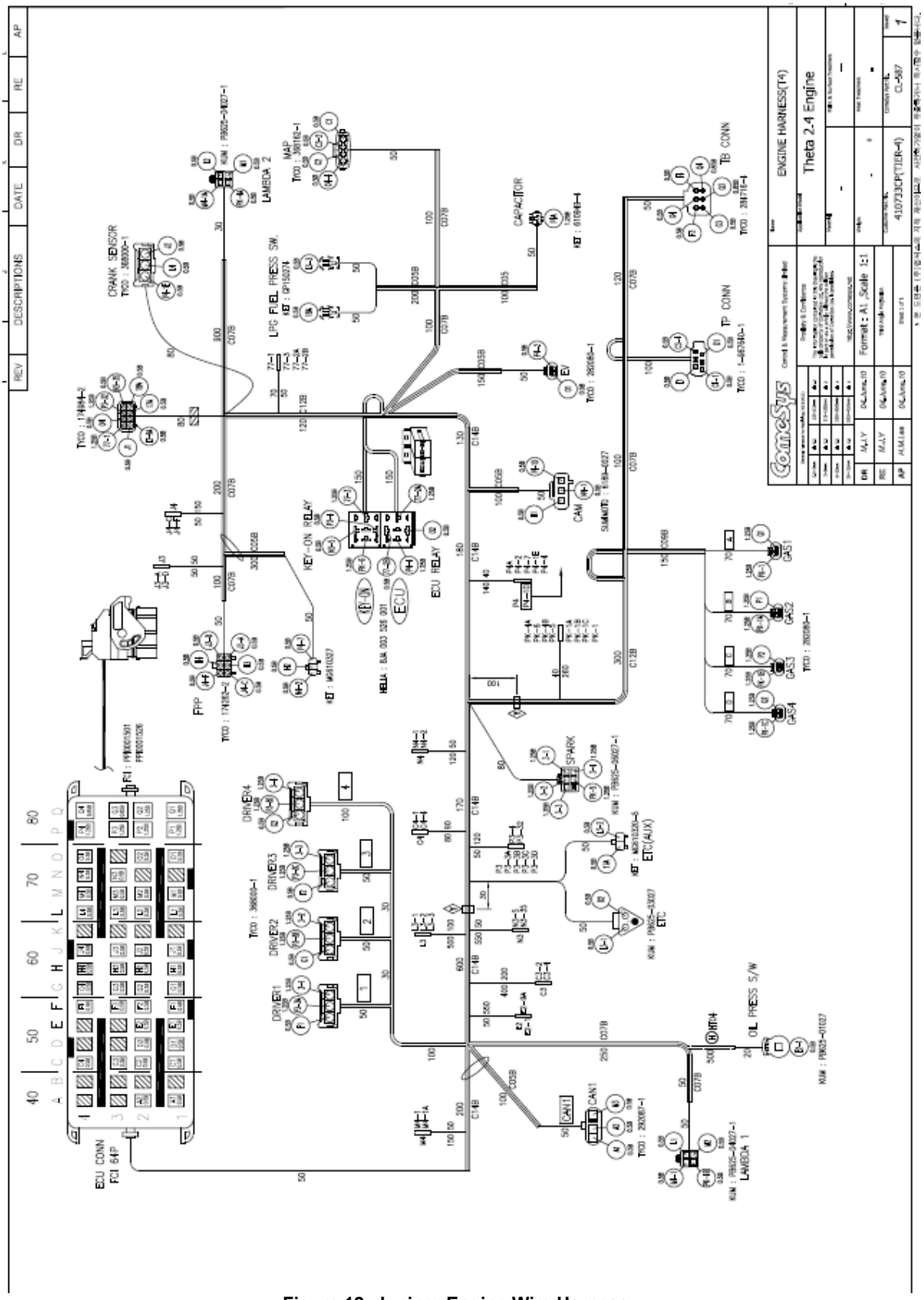


Figure 12: Juniper Engine Wire Harness

Emissions Catalyst

In order to meet 2007 and 2010 emission requirements a 3-way catalyst must be installed in the engine exhaust to reduce emissions of NOx, HC and CO. The engine control system monitors the exhaust upstream of the catalyst and uses this information to control the air-fuel mixture. By using the signal from the oxygen sensor the ECU can increase or decrease the amount of oxygen in the exhaust by modulating the fuel injection pulse width and thus adjusting the air-fuel ratio. This control scheme allows the ECU to make sure that the engine is running at the correct air to fuel ratio so that the catalyst can perform as required to meet the emissions requirements. The emissions catalyst is most commonly installed integral with the exhaust muffler. Alternatively, the catalysts can be "canned" in a separate enclosure and installed upstream of the muffler. It is important that the catalyst be installed in accordance with Juniper's installation instructions to ensure adequate performance and, thus, minimal tailpipe emissions. Forklift trucks sold outside of North America will not have an emissions catalyst installed.

The specifications of the three-way emissions catalyst to be installed with the Juniper 2.4L industrial engine are as shown below:

Supplier	Umicore, Inc Umicore Part No.: 47.6353.0000 Juniper Part No. : 1000013
Substrate	Emitec, Inc. Material: stainless steel Cell density: 400 cpsi
Size	L = 170mm Dia = 118mm Volume: 1640 ml

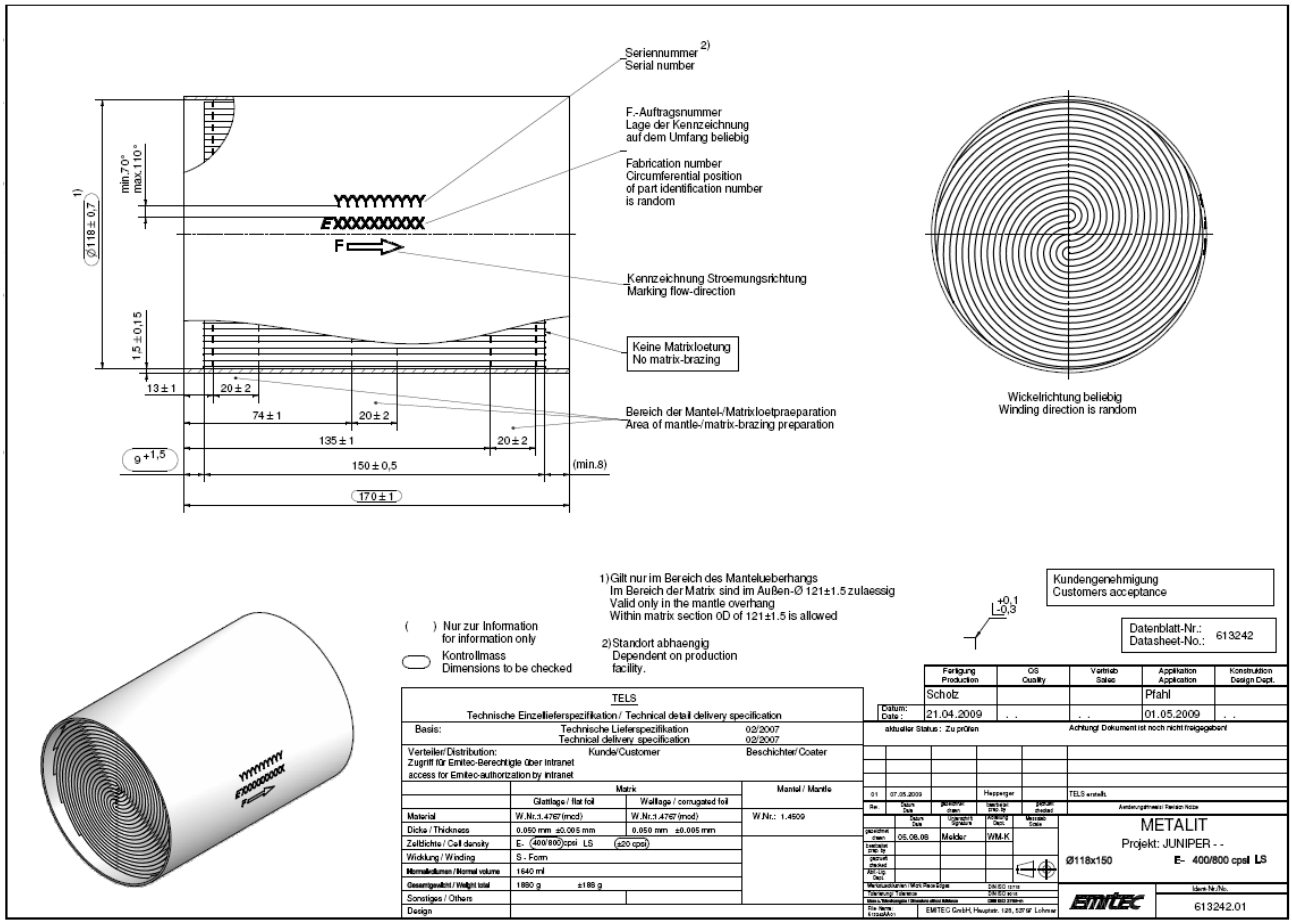


Figure 13: Juniper Catalyst Substrate

Oxygen Sensors

The Juniper fuel system control utilizes two oxygen sensors. One sensor is a pre-catalyst sensor that detects the amount of oxygen in the exhaust stream and is considered the primary control point. The control system uses feedback from the oxygen sensor to regulate the fuel delivery and maintain a stoichiometric air-fuel ratio. The second sensor is a post-catalyst sensor that detects the amount of oxygen after the catalyst. This sensor is used in conjunction with an ECU algorithm to detect the level of catalyst conversion efficiency. Once an oxygen sensor reaches approximately 600°F (316°C) it becomes electrically active. The concentration of oxygen in the exhaust stream determines the voltage produced. If the engine is running rich, little oxygen will be present in the exhaust and voltage output will be relatively high. If the engine is running lean more oxygen will be present and the voltage output will be low.

In order for the sensors to activate and provide a signal prior to reaching operating temperature a heated element is included in the sensor housing. The oxygen sensor stoichiometric air-fuel ratio voltage target is approximately 450 mV and changes slightly as a function of speed and load. When the pre-catalyst oxygen sensor sends a voltage signal less than 450 mV the ECU interprets the air-fuel mixture as lean. The ECU then increases the PWM duty cycle sent to the fuel injectors in order to increase the flow of fuel to each cylinder. The opposite is true if the ECU receives a voltage signal above 450 mV from the oxygen sensor. The air-fuel mixture would then be interpreted as being too rich and the ECU would decrease the PWM signal to the injectors to decrease the flow of fuel.

Various tables set up in the software of the ECU have been calibrated to precisely control the way in which in the injectors vary the lambda output above and below the stoichiometric point. The table outputs are set according to engine speed and load and control the leaning rate, the lean-to-rich step size, the richening rate, the rich hold time and the rich-to-lean step size. This control is required to ensure that the lambda fluctuation rate and amplitude are appropriate for the specific speed and load condition for an optimized catalytic conversion efficiency.

Figure 14: Pre-Catalyst Oxygen Sensor on Exhaust Manifold

Electronic Throttle Body

The electronic throttle system controls engine output (speed and torque) through electronic control of mass airflow to the engine. In the event of an electrical disconnection or other related failure the throttle plate returns to a limp-home position where a reduced speed and torque output is available. This throttle position provides sufficient airflow for the engine to move the vehicle on level ground.

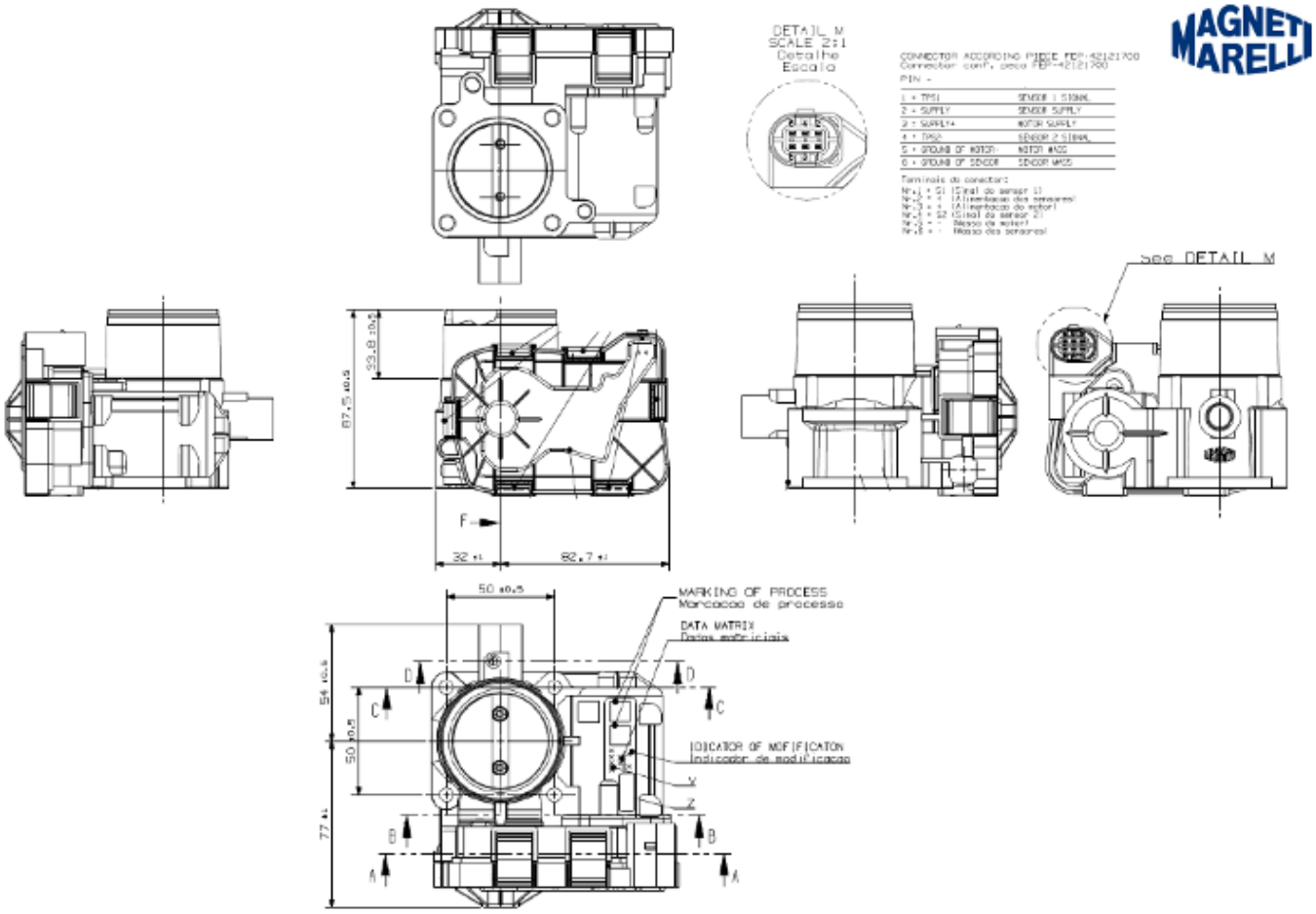


Figure 15: Magneti Marelli 36mm Throttle Body

The ECU controls the throttle valve based on engine rpm, engine load, and information received from the foot pedal. Two potentiometers on the foot pedal assembly monitor accelerator pedal travel. The electronic throttle used in the Juniper fuel system is manufactured by Magneti Marelli. This is a single unit assembly which includes the throttle valve, throttle-valve actuator (DC motor) and two throttle position sensors (TPS). The ECU calculates the correct throttle valve opening that corresponds to the vehicle's demand, makes any adjustments needed for adaptation to the engine's current operating conditions and then generates a corresponding electrical signal to the throttle-valve actuator.

The Juniper system uses a dual TPS design (TPS1 and TPS2). The ECU continuously checks and monitors all sensors and calculations that effect throttle valve position whenever the engine is running. If any malfunctions are encountered the ECU will initiate the appropriate OBD action, which will result in the engine reverting to a limp-home condition. A problem with the throttle actuator will lead to shutting down the engine completely.

Ignition Control System

Spark-ignited engines require accurate control of spark timing and spark energy for efficient combustion. The Juniper ignition system provides this control. The system consists of the following components:

- ECU
- Power transistors
- Ignition coils
- Spark plugs
- Crankshaft position sensor
- Camshaft position sensor

The ECU, through use of embedded control algorithms and calibration variables, determines the proper time to start energizing the coil and fire the spark plug. This requires accurate crank/camshaft position information, an engine speed calculation, coil energy information, and target spark timing. The ECU controls spark energy (dwell time) and spark discharge timing.

Under normal operating conditions the ECU will use load and engine speed to derive the correct ignition timing. In addition to load and speed there are other circumstances under which the ECU may need to vary the ignition timing, including low engine coolant temperature, high or low ambient temperature, start-up conditions and for idle speed control.

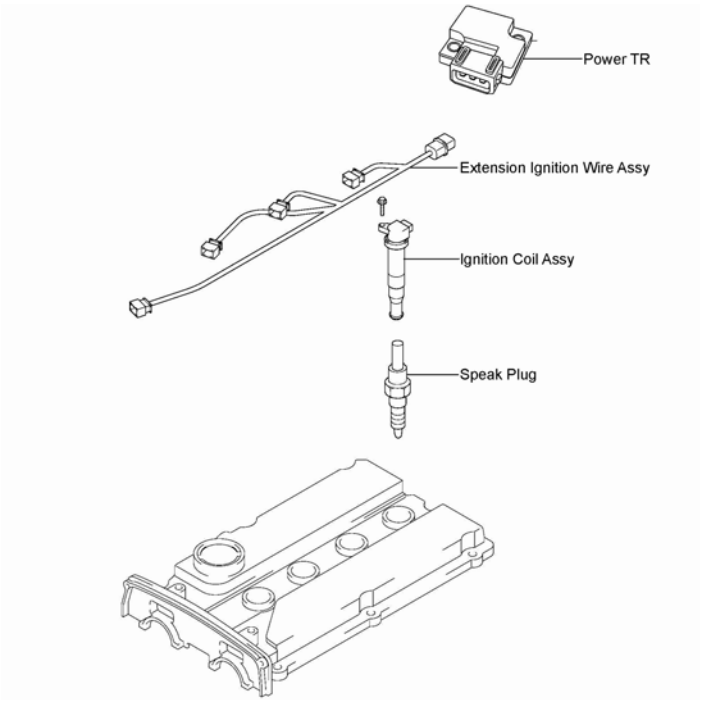


Figure 16: Ignition control Components

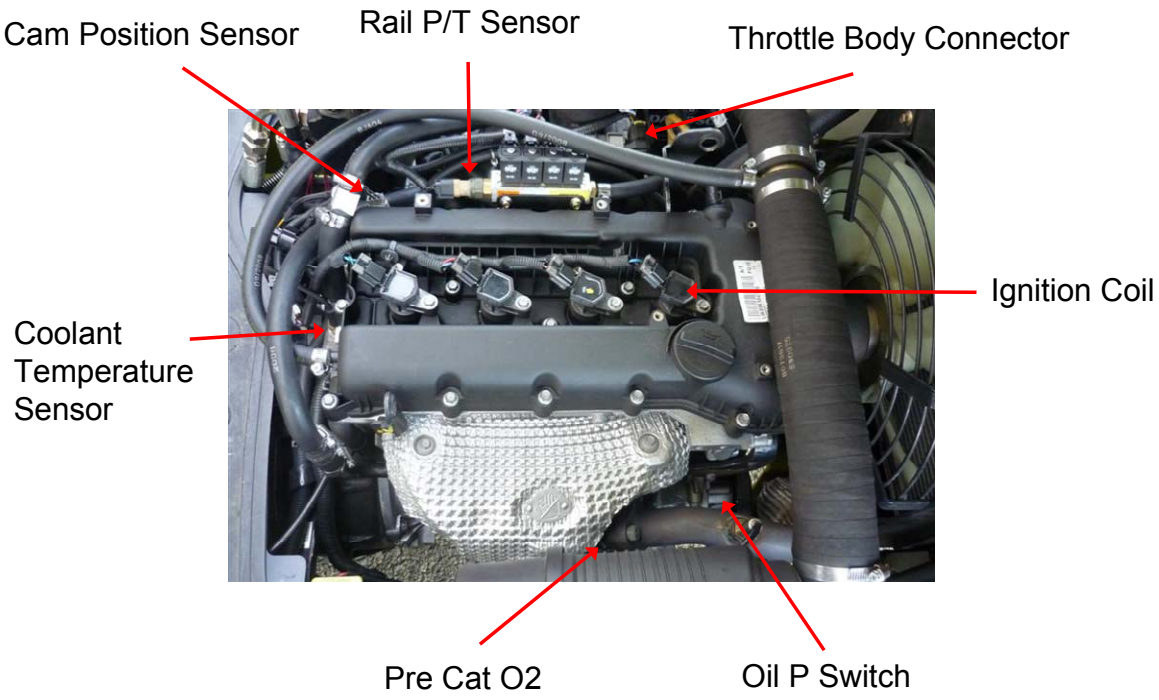
Power Transistors

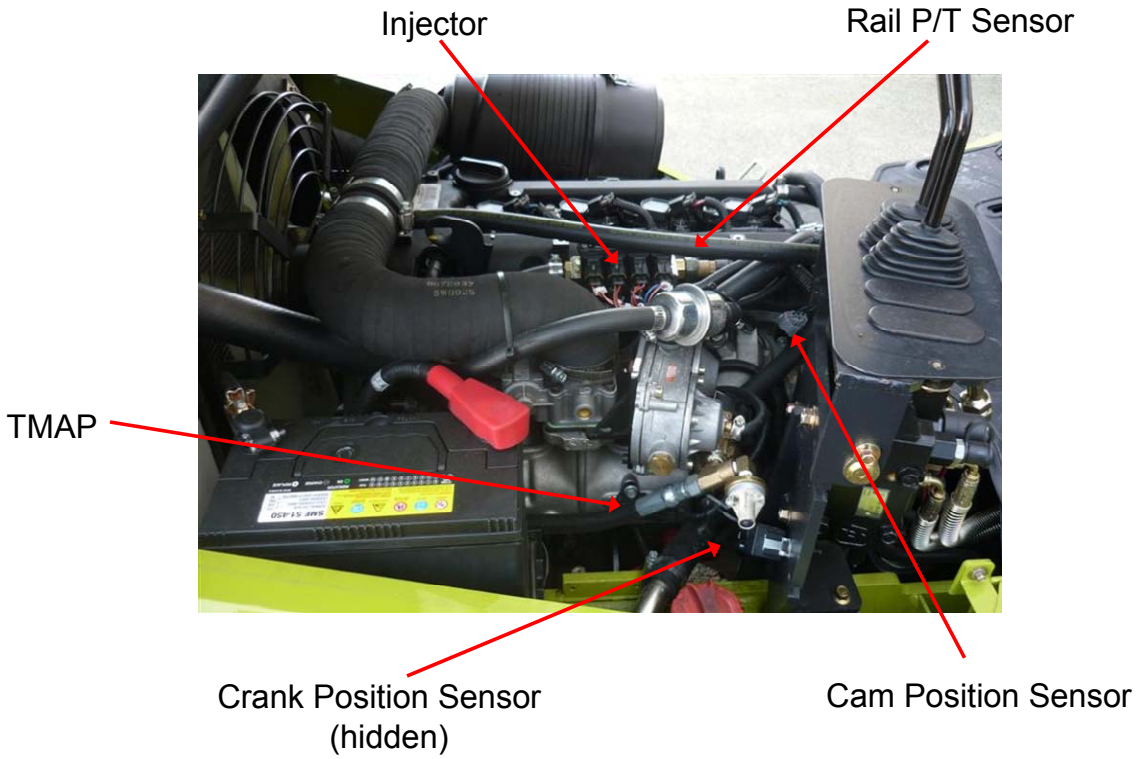
The ECU controls the engine ignition coils through the power transistors; one for each cylinder. The power transistors are provided by Hyundai and are designed specifically to regulate the coil current in the 2.4L Hyundai engine.

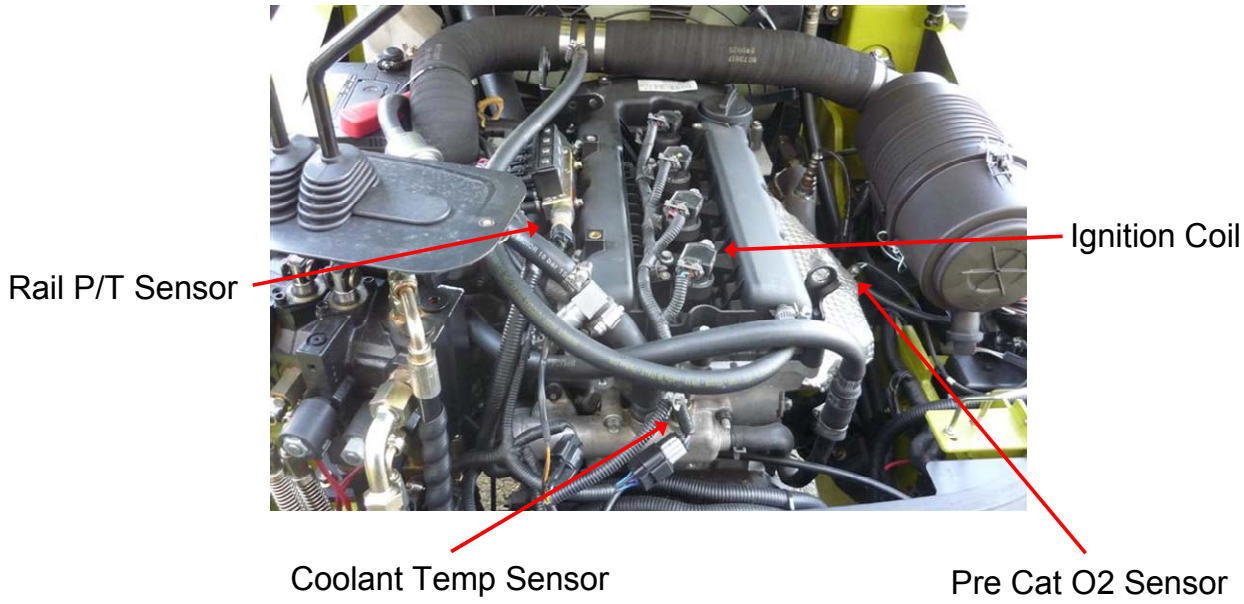
Technical Specifications:

- Rating voltage: 12 Vdc
- Operating supply voltage: 5 - 16 Vdc
- Operating Temperature: -30°C to 110°C
- Storage Temperature: -40°C to 120°C
- Operating Revolution: 40 to 8000 [rpm]
- Vibrating Endurance: 25 G, 100 to 300 Hz for 20 hrs.

Locations of Major Sensors & Components




Injector
Rail P/T Sensor
TMAP
Crank Position Sensor
(hidden)
Cam Position Sensor


Rail P/T Sensor
Ignition Coil
Coolant Temp Sensor
Pre Cat O2 Sensor

5. Recommended Maintenance

The following section lists general maintenance which is required to keep your engine in fuel system in proper operating condition. For more details refer to the engine manual.

Note: The Juniper fuel system is designed for use with LPG that meets the specifications of HD-5 (GPA Standard 2140) or HD-10 fuel. Use of lower quality fuel may be harmful to the fuel system and/or engine and could be cause for disallowing a warranty claim.

General Maintenance Guideline

Category	Item	Action	Hour Intervals		
			Daily	every 400 hours or 3 months	every 2000 hours or 1 year
General	MIL	Check MIL lamp at key-on. Repair any faults as indicated	X		
Fuel System	Fuel Tank / Shutoff	Verify proper mounting & valve function	X		
	Fuel Hose & Fittings	Inspect for cracks, leaks, abrasion	X		
	Regulator / Injector rail	Inspect for leaks			X
	Fuel lock-off	Verify functionality			X
Air Intake	Air filter	Inspect indicator, replace if neccesary	X		
	Air inlet system	Inspect	X		
	Intake manifold gasket & vacuum hoses	Inspect for leaks			X
	Electronic throttle body	Inspect for oil deposits from flow reversion			X
Ignition	Wiring to control modules	Inspect for cracks, abrasion			X
	Coil-over-plug units	Inspect for cracks, abrasion			X
	Spark plugs	Change (recommendation - not mandatory)			X
Exhaust	Exhaust manifold & piping	Inspect for cracks, leaks, abrasion	X		
	Pre-Catalyst Oxygen sensor	Check wire is not damaged / burnt	X		
	Post-Catalyst Oxygen sensor	Check wire is not damaged / burnt	X		
	PCV valve	Check for leaks	X		
	PCV air feed	Inspect for cracks, leaks, abrasion	X		
Engine - General	Coolant	Check level, top-off if necessary	X		**change**
Additional engine maintenance listed in engine manual	Coolant hoses, fittings	Check for cracks, looseness, swelling, deterioration		X	
	Engine oil	Change		X	
Vehicle Electrical	Battery & main cables	Inspect connections, check for corrosion			X
	Starter & cables	Inspect connections, check for corrosion			X
	Foot pedal	Check that travel is clear of interferences	X		
	ECU	Inspect mounting bolts			X
	Harnesses	Check for looseness, proximity to exhaust	X		

Fuel System Leak Testing

- Prior to starting engine, listen and smell for fuel leaks around the engine and LPG storage bottle.
- Using an approved leak check solution, spray liberally on fuel system hose and components.
- Visually inspect for bubbles to form, thus indicating a leak. Repair any leaks prior to proceeding.
- Start the engine and continue the test, noting that furl pressure should now be present over the entire system.

General Fluid Leaks

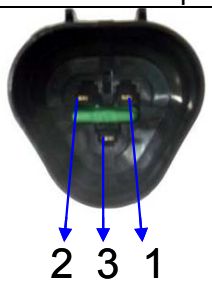
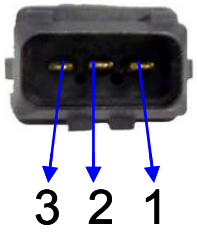
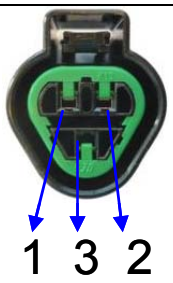
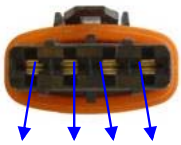
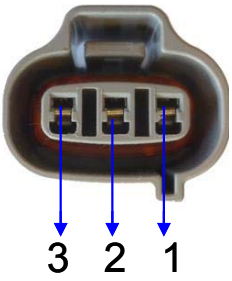
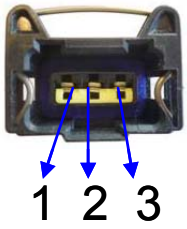
- Inspect the engine and floor beneath for oil and/or coolant leaks
- Start the engine and allow it to reach operating temperature.
- Inspect the warm engine for leaks.
- Repair any leaks prior to operating vehicle.

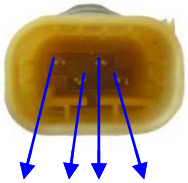
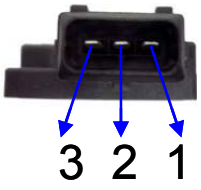
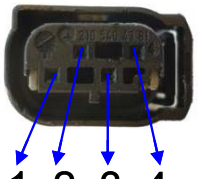
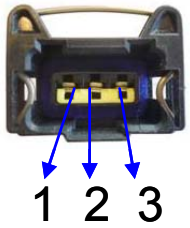
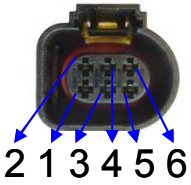
Coolant System

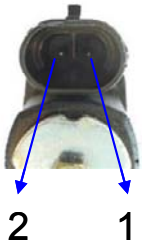
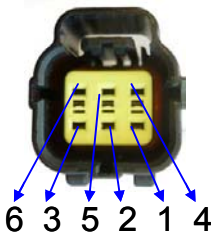
- Visually inspect the coolant hoses and clamps, including coolant hose to and from the engine and radiator and to and from the regulator.
- Coolant must be drained prior to removing a hose or replacing a clamp, and this should be done with the engine cold.
- The coolant level in the radiator must be maintained within the prescribed range. Top up the coolant when necessary.
- Take care when opening the radiator cap – turn the cap slowly to relieve pressure prior to removing.

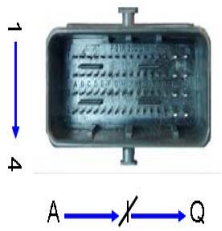
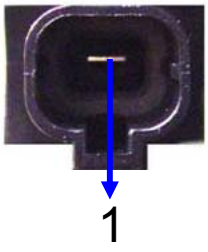
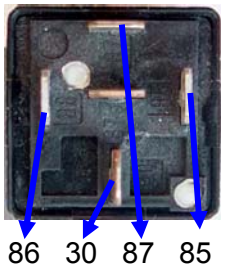
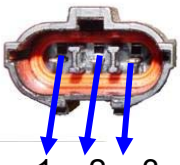
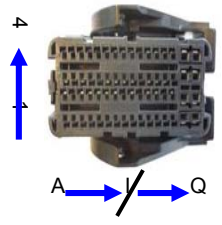
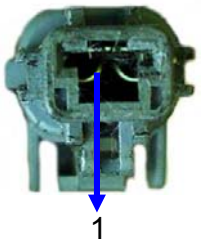
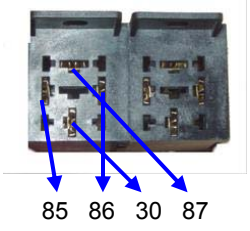
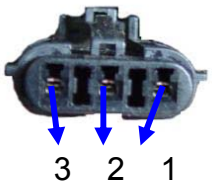
Electrical System & Harness

- Inspect the complete harness, battery, relays, etc. for integrity and note any broken or chaffed wires, connectors or components.
- All wires must be secured to avoid contact with hot or moving parts.
- Repair any problem areas immediately.
- Refer to the following Sensor pin-out tables for troubleshooting of the wiring harness:

Sensor	Coolant Temp	TMAP	Camshaft	Crankshaft
Sensor Pin-out				
Harness Pin-out				
Key On Pin Voltage With Sensor Disconnected	1. Ground 2. 5 +/- 0.5V 3. Not used	1. 5 +/- 0.5 V 2. 5 +/- 0.5 V 3. 5 +/- 0.5 V 4. Ground	1. Battery V 2. Ground 3. 6.5 +/- 0.5 V	1. Battery V 2. Ground 3. 6.5 +/- 0.5 V

Sensor	TPrail	Injector	Power Transistor	Throttle Body
Sensor Pin-out				
Harness Pin-out				
Key On Pin Voltage Sensor Disconnected	1. Ground 2. 5 +/- 0.5V 3. 5 +/- 0.5V 4. 5 +/- 0.5V	1. Battery V 2. 1.3 +/- 0.3 V	1. Ground 2. Ground 3. Battery V	1/4. 3.75 +/- 0.5V 2/3. 5 +/- 0.5V 5/6. Ground

Sensor	O_2 Sensor 1	O_2 Sensor 2	Foot Pedal	Fuel Solenoid
Sensor Pin-out				
Harness Pin-out				
Key On Pin Voltage Sensor Disconnected	1. Ground 2. 2 +/- 1V 3. Ground 4. Battery V	1. Ground 2. 2 +/- 1V 3. Ground 4. Battery V	1/2. 5 +/- 0.5V 4/5. 5 +/- 0.5V 3/6. 0 +/- 0.5V	1. 0 +/- 0.5 V 2. Battery V

Sensor	ECU Connector	Condenser	Main Relay A & B	Speed Sensor
Sensor Pin-out				
Harness Pin-out				
Key On Pin Voltage Sensor Disconnected	It is not suggested to turn key on with ECU disconnected	1. Battery V	30. Battery V 85. Battery V 86. Ground 87. Battery V	1. Battery V 2. 6.5 +/- 0.5 V 3. Ground

Ignition System

- Inspect the ignition assembly and note any wear or abrasion on the coil assemblies or harness.
- Remove the coil assemblies from the spark plugs.
- Remove the spark plugs from the engine.
- Inspect the plug gap and replace if necessary.
- Gap the new spark plugs to the proper specifications.
- Apply anti-seize compound to the spark plug threads and re-install.
- Re-install the four ignition coil assemblies.

LPG Regulator Service

Before servicing the LPG regulator, make certain that the LPG tank main valve is closed. Run the engine until the pressure drops low enough to stall the engine. This drains the trace quantity of fuel in the line. As a secondary safety measure, disconnect the LPG shutoff valve to ensure that this vale remains closed.

The following procedure is used to access the regulators first and second stage membranes and other internal components for cleaning or replacement.

Disconnect the LPG rubber hose (V) (vent out the remaining gas in an open environment). Remove then the water hoses (III and IV) and the vacuum hose (VI).

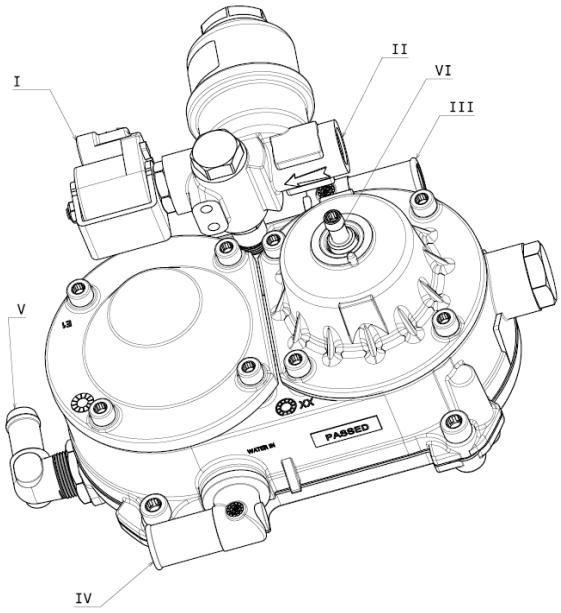


Fig. 1

While stopping the base nut with a 14mm Allen wrench, use another 16mm Allen wrench to unscrew (20Nm) the hex nut on top of filter (Fig.2). Once loose, pull out the filter: there's no need to disconnect LPG copper pipe (II). Now the pressure regulator is free to be removed from the engine bay and placed on a flat surface. Note, Fig. 2 shows the Valtek valve and filter configuration. The AFC valve option is not attached directly to the regulator body.

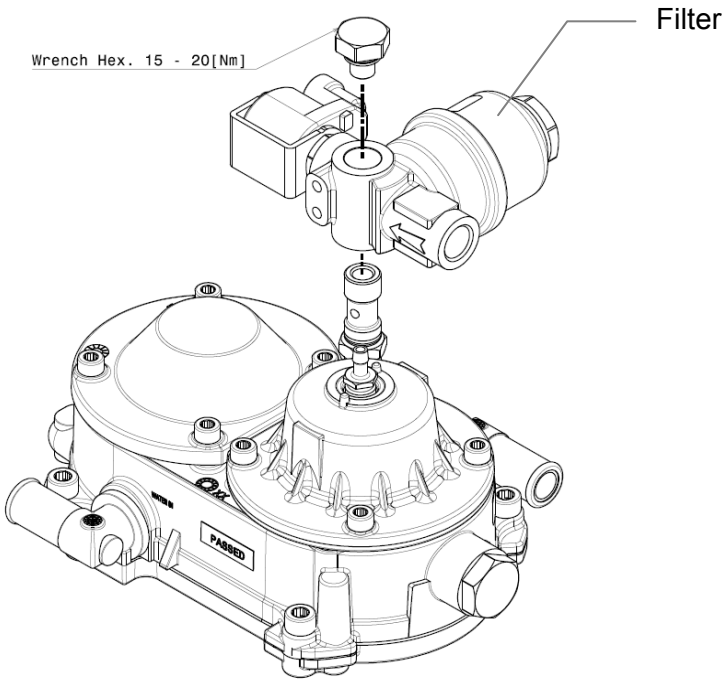


Fig. 2

FIRST STAGE

Use a 4mm Allen key to unscrew (5 Nm torque) the four hex bolts of the first stage's cover (Fig.3), taking care that the internal springs will push away the cover. once the cover is removed, take out the big spring, the aluminum plate and the small spring that are standing inside.

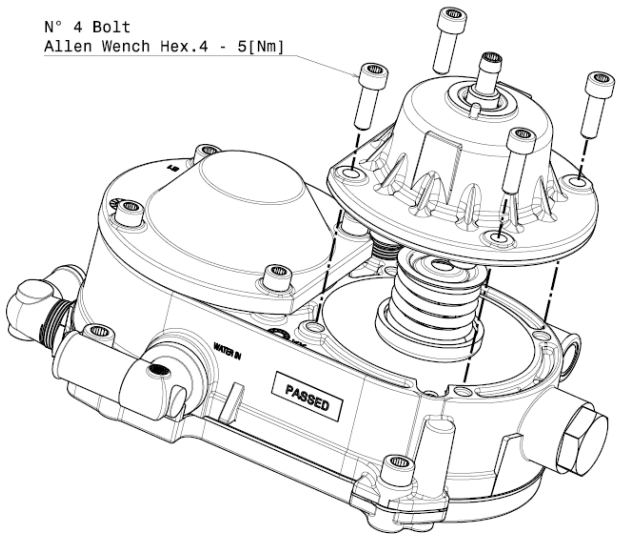


Fig. 3

The safety spring assembly is now exposed (Fig.4) and should be disassembled: hold the internal 3mm hex with an Allen key while unscrewing the outside 14mm nut with an Allen wrench.

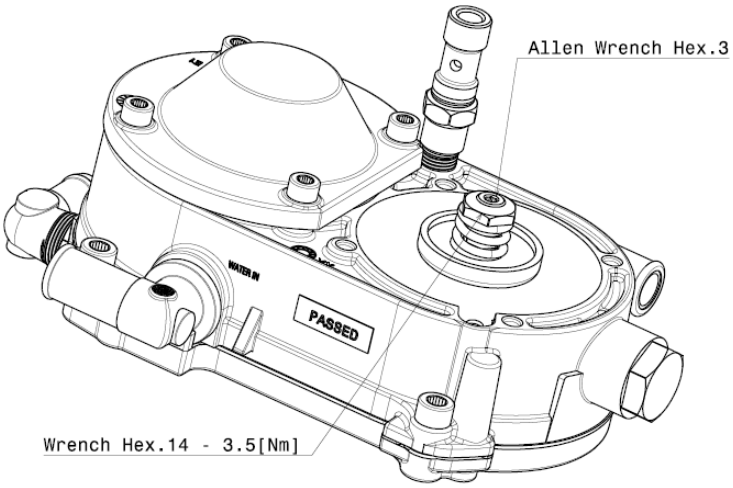


Fig. 4

Now the assembly is loose (Fig. 5): remove the 14mm hex nut and the safety spring, then pull out the plastic centering plate and the rubber membrane (Part number 01815). The membrane should be replaced with new one from the repair kit.

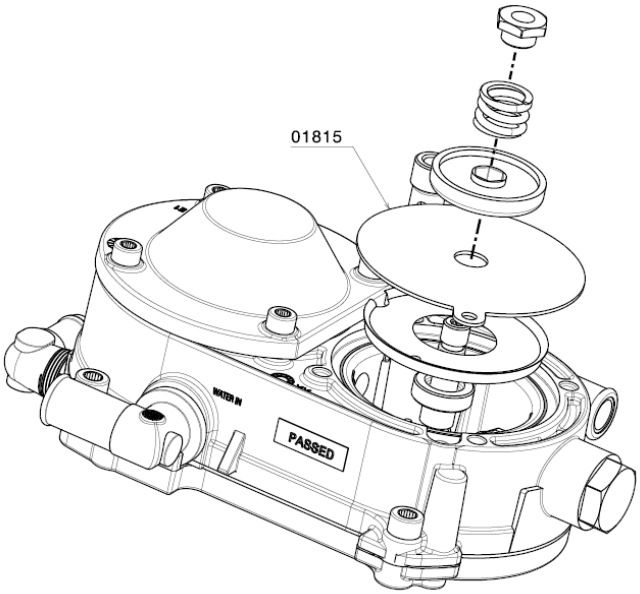


Fig. 5

- Take note of the orientation of the membrane and the centering plate.
- Remove the bottom protection plate: the first stage leverage (E) is now exposed (Fig. 6).
- Use a PH1 Phillips screwdriver to unscrew (3Nm torque) the two screws (D), then pull out the high pressure shutter (C).

- Remove the small rubber disk (A) off the tip of the shutter and replace with the new one from the repair kit (part number 01599). Visually check (without disassembling) that the high pressure brass seat (F) is free of dents or defects which could affect the sealing.

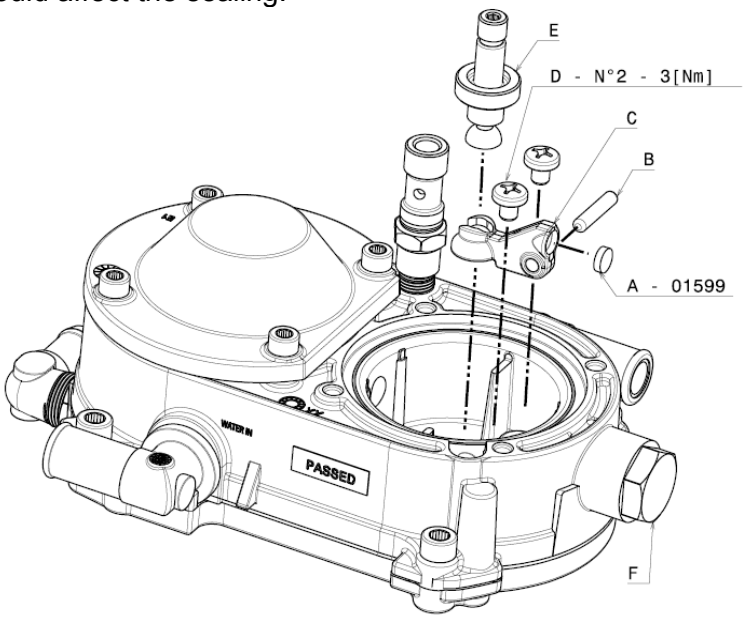


Fig. 6

When reassembling the safety spring assembly pay attention to the centering plate (Fig.5), which has a centering rib that needs to be aligned with the membrane. The 14mm hex nut that closes the safety spring assembly should be tightened to 3.5Nm torque.

SECOND STAGE

Use a 4mm Allen key to unscrew (5Nm torque) the four hex bolts of the second stage's cover (Fig.7); then remove the cover.

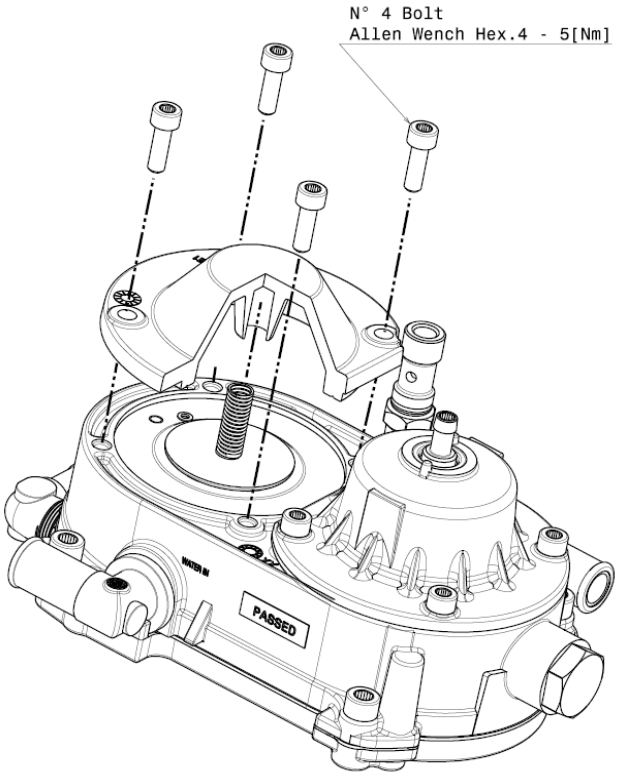


Fig. 7

Remove the spring (B) that's standing on top of the rubber membrane (Fig.8), then replace the membrane (A) with new one (part number X0039).

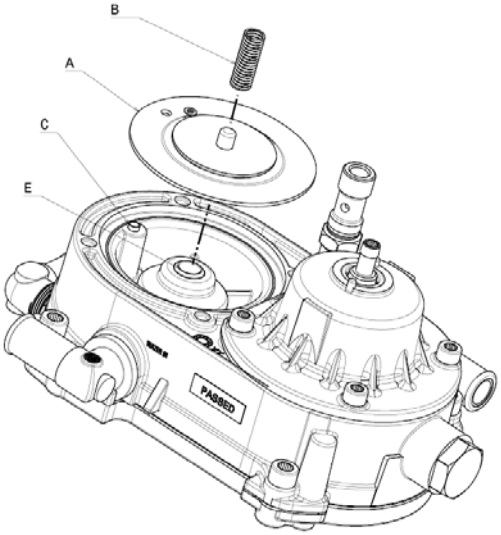


Fig. 8

When reassembling, pay attention to the membrane, which should be properly aligned with the centering rib (E) and the small tube (C). When reassembling the cover, make sure that the spring (B) properly slides into the guide inside the cover.

LPG Shutoff Valve – Option 1, Valtek

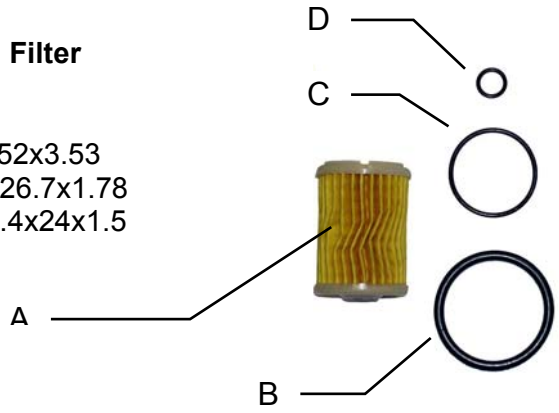
The shutoff solenoid should be tested periodically to endure it will close when power is removed from the coils. To test, start the engine and then disconnect the solenoid wire harness connector. The valve should close and the engine should be quickly starved of fuel. If the engine does not shut down then shut it manually immediately. Replace the shutoff valve prior to operating the engine again.

LPG Liquid Filter – Option 1, Valtek

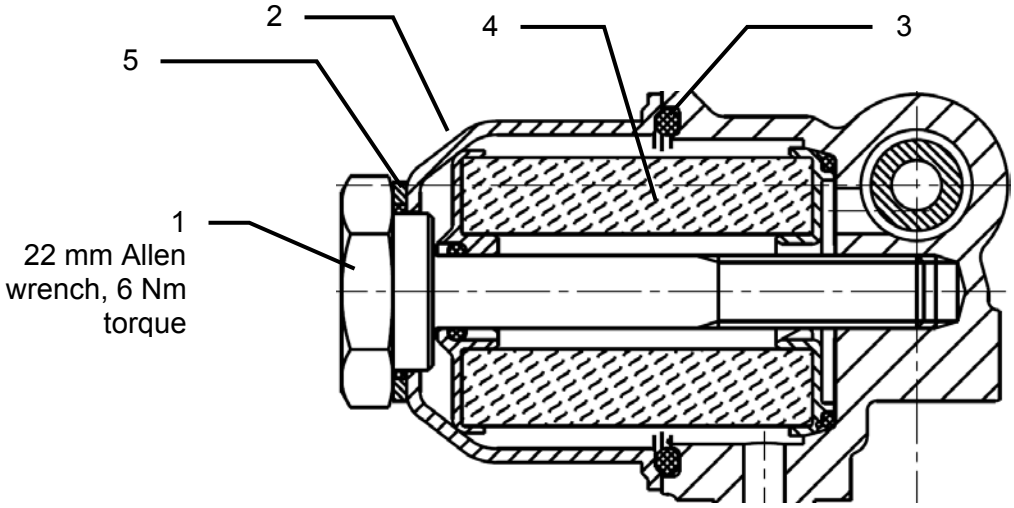
The following procedure should be used to access and filter element for inspection and replacement. Use the same procedure to evacuate LPG from the system as described in the previous section on regulator service.

Maintenance Kit for LPG Liquid Filter

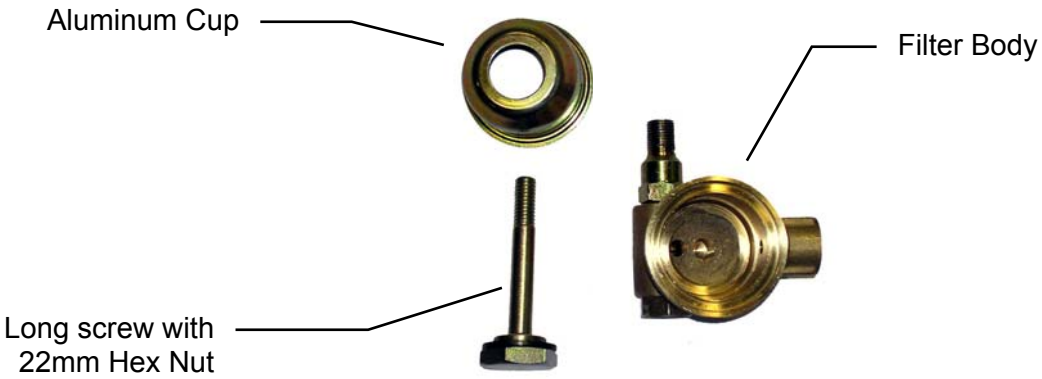
A) paper cartridge
B) brown rubber o-ring Ø 34.52x3.53
C) thin black rubber o-ring Ø 26.7x1.78
D) metal/rubber washer Ø 17.4x24x1.5



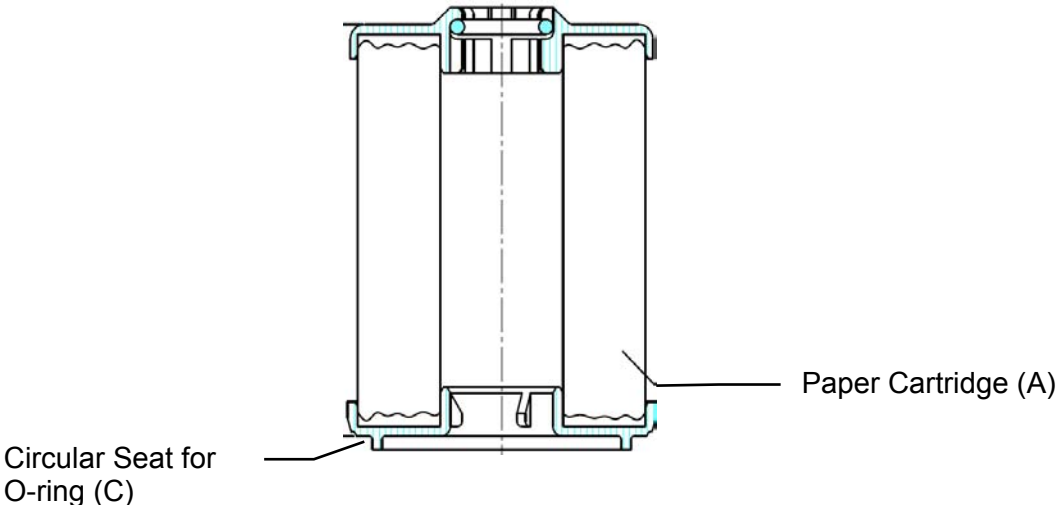
With a 22 mm Allen wrench, loosen the hex nut on top of the filter (1). When the screw is loose, pull away the aluminium cap (2) from the filter body. Now the brown rubber O-ring (3) at the base of the aluminium cup is exposed and can be removed. Blow away any dust residue inside the filter body.



Slip off the used paper cartridge (4) from the long screw and discard. Then slip off the long screw from the aluminum cup: the sealing metal/rubber washer (5) on the base of the hex nut is now exposed and should be replaced with new one (D).



Now take the new paper cartridge (A) and fit the new black rubber O-ring (C) on the plastic circular seat on the bottom of the cartridge.

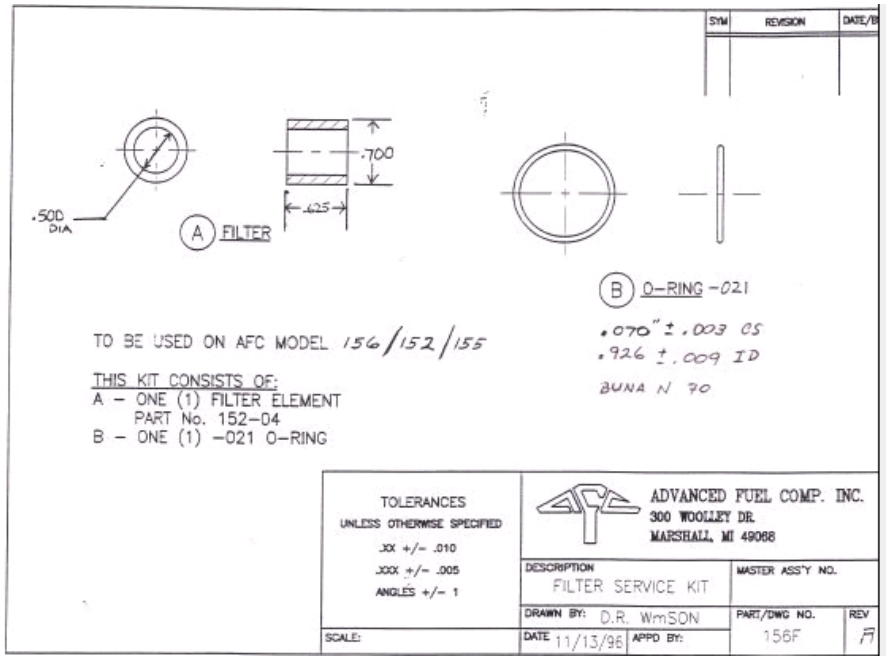


Next put the new paper cartridge (A) into the aluminium cup, so that its black rubber O-ring (C) will face the filter body; then push the long screw into the aluminium cup and thru the paper cartridge. Finally put in place the new brown rubber O-ring (B) at the base of the aluminium cup.

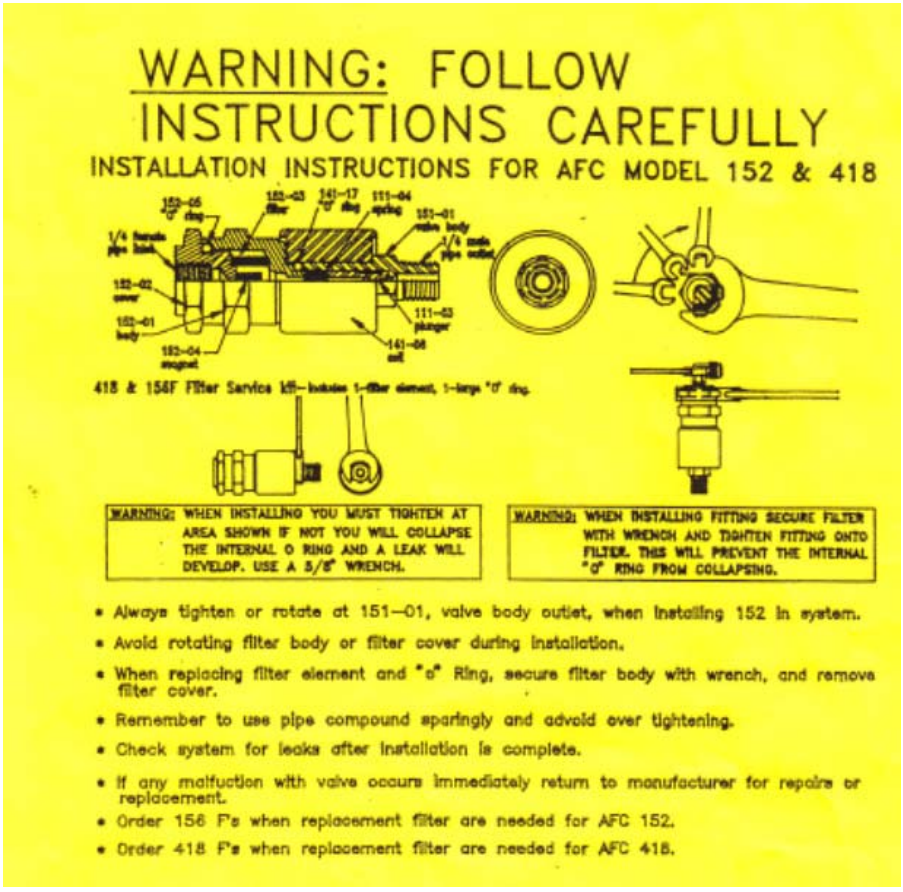
Then put the aluminum cup back in place, taking care to align the long screw with its threaded hole on the filter body. Use a 22 mm Allen wrench to tighten the hex nut to 6 Nm torque.

LPG Shutoff Valve – Option 2, AFC

AFC filter maintenance kit:



AFC filter maintenance instructions:


WARNING: FOLLOW INSTRUCTIONS CAREFULLY
INSTALLATION INSTRUCTIONS FOR AFC MODEL 152 & 418
418 & 156F Filter Service Kit—Includes 1-filter element, 1-large "O" ring.
WARNING: WHEN INSTALLING YOU MUST TIGHTEN AT AREA SHOWN IF NOT YOU WILL COLLAPSE THE INTERNAL O RING AND A LEAK WILL DEVELOP. USE A 5/8" WRENCH.
WARNING: WHEN INSTALLING FITTING SECURE FILTER WITH WRENCH AND TIGHTEN FITTING ONTO FILTER. THIS WILL PREVENT THE INTERNAL "O" RING FROM COLLAPSING.
• Always tighten or rotate at 151–01, valve body outlet, when installing 152 in system.
• Avoid rotating filter body or filter cover during installation.
• When replacing filter element and "o" Ring, secure filter body with wrench, and remove filter cover.
• Remember to use pipe compound sparingly and advoid over tightening.
• Check system for leaks after installation is complete.
• If any malfuction with valve occurs immediately return to manufacturer for repairs or replacement.
• Order 156 F's when replacement filter are needed for AFC 152.
• Order 418 F's when replacement filter are needed for AFC 418.

LPG Rail & Injectors

There is no maintenance required for the LPG rail and injectors under normal operation, but the assembly should be inspected periodically to endure the integrity of the connecting hoses and clamps. Deterioration of injector performance will eventually result in one or more of the injectors providing to little or too much fuel. This will be sensed by the diagnostic system, if it reaches a problematic level, due to the extreme richness or leanness of the resulting air/fuel ratio, and will be indicated with the appropriate MIL code. When this occurs it is time to either repair the rail using the rebuild kit or replace the entire fuel rail. The fuel rail repair or replacement should normally occur between 5000 and 10,000 hours, depending on engine operating conditions, duty cycle and fuel quality.

Other than normal wear, as described above, there could be conditions of low quality fuel that cause one or more injectors to either stick open or closed. It could also be possible for an injector solenoid to fail. There is a troubleshooting sequence that can be carried out through the service tool to determine if a particular injector is receiving an electric pulse and is able to open and close. With the engine shut off but the key in the on position and the specific injector injection hose removed a signal can be sent through the service tool to cycle that injector open and closed. This should result in a detectable amount of LPG passing through the hose. Although only a small amount of fuel will be discharged, this test should still be done in an open and well ventilated area. If no LPG is detected then either the solenoid is not opening the injector or it is stuck closed. If the fuel is passing through the hose constantly without stroking the valve then the injector is stuck open. Either scenario means that the complete fuel rail has to be repaired or replaced. When performing this test it should be carried out in as short a time as necessary. Once complete be sure to turn the key to the off position to close the solenoid shutoff valve.

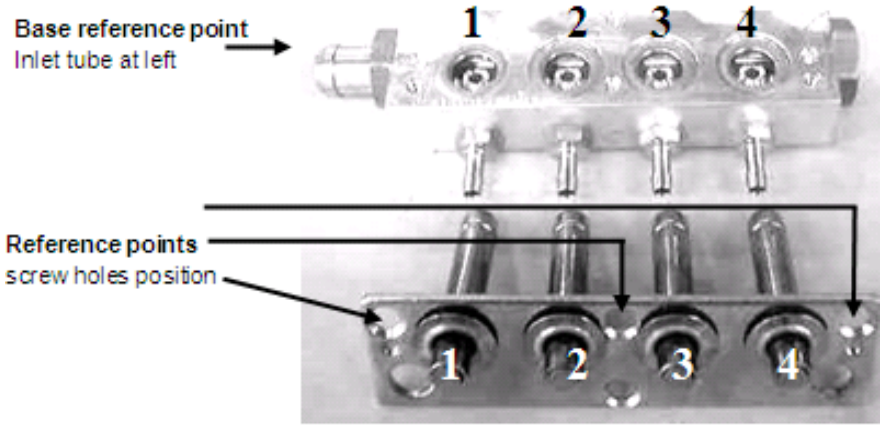
Fuel Rail Repair Instructions:

Before using the fuel rail repair kit, make certain that the LPG tank main valve is closed. Run the engine until the pressure drops low enough to stall the engine. This drains the trace quantity of fuel in the line. As a secondary safety measure, disconnect the LPG shutoff valve to ensure that this vale remains closed.

1. Remove the fuel rail assembly which is to be rebuilt from the engine compartment
2. Remove the four seeger rings using a suitable tool and the four elastic washers from the top of the solenoid coils.
3. Remove the coils from the tubes.
4. Remove the 3 screws from the fuel rail body and the retainer metal plate with the tubes and plungers.
5. Check the cleanliness of the inside cavity of the fuel rail body and the (diameter 12.42mm x 1.78mm) O-ring. If necessary remove the dirty using compressed air or a suitable solvent, such as gasoline.

WARNING: The rubber O-Ring could be damaged if a non-suitable solvent is used.
WARNING: Do not leave the aluminium body and the rubber parts in contact with the solvent after cleaning.
WARNING: Be careful not to damage the gas-tight seats.

6. Carefully place the clean O-rings in their proper body seats.

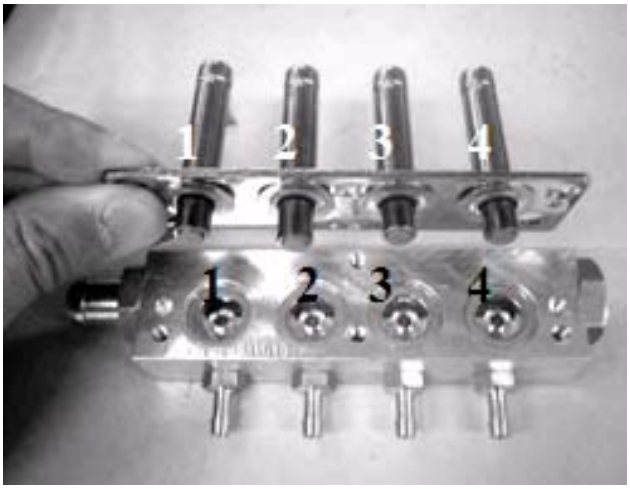


Picture 1 - shows the numbering of the plunger tubes and the rail seats with respect to their reference points.

7. Bring and match the maintenance kit with the aluminium fuel rail body (see pictures 1 and 2)

WARNING: the protrusion reference points of the plate need to match the hole reference points on the fuel rail body.

8. Tighten the 4 screws with 2 Nm torque and then assemble the 4 coils, elastic washers and seeger rings, using the proper tool.
9. Check the integrity of the gas seal of the fuel rail assembly.
   a) Internal gas tight: Supply the inlet connector with 0.5 bar compressed clean air and verify that there is no leakage at each of the 4 outlet connectors.
   b) External gas tight: Supply the inlet connector with 0.5 bar compressed clean air. Close the 4 outlet connectors (diameter 5mm) using a proper cap or a tight tube. Energise the 4 coils in parallel with 12 VDC. Verify that there is no air leakage at all from any part of the fuel rail assembly. The integrity o the gas seal should be checked using instruments capable to detect leakage of 15cc/hr.
10. Reinstall the fuel rail on the engine bracket and properly fit all hoses and electrical connections. Open the manual valve of the gas cylinder and switch on the engine key in order to supply the fuel rail inlet with gas pressure. Carefully check that the entire system is gas tight.



Picture 2 - Do not modify the tube positions. Be careful when handling the replacement assembly, as the plungers can easily fall out of the tubes. It is important to match the correct plunger with its tube. Place the new assembly on the base, fitting the plungers over the seats.

Throttle Body & Intake Tubing

Visually inspect the throttle body housing and motor enclosure to ensure it is fully sealed. Repair and/or replace if necessary. Failures of the electronic throttle will be sensed by the diagnostic system and will be indicated by the appropriate MIL code.

Periodically check the inlet air tubing to ensure the integrity of the system. There should be no cracks or holes in the inlet tubes and clamps should be securely in place. The air inlet filter indicator should be checked periodically and the element replaced when necessary. The blow-by connections and hose should be inspected as well.

TMAP Sensor

Verify that the TMAP sensor is mounted properly on the manifold and there are no vacuum leaks around it. In case of leaks the sensor should be reinstalled with lubricant on the o-ring seal, otherwise replaced. A general failure of the sensor will trigger a MIL signal in the OBD system.

Exhaust System & Catalyst

- Start the engine and allow it to reach operating temperatures.
- Perform visual inspection of exhaust system from the engine all the way to the tailpipe. Any leaks, even after the post-catalyst oxygen sensor, can cause the sensor output to be effected (due to exhaust pulsation entraining air upstream). Repair any/all leaks found. Ensure the length from the post catalyst sensor to tailpipe is the same as original factory.
- Ensure that wire routing for the oxygen sensors is still keeping wires away from the exhaust system. Inspect the oxygen sensors for signs of damage from the hot exhaust.
- The catalyst is designed to maintain emissions compliance for 7 years or 5000 hours. In practice the catalyst should be effective for much longer than the minimum requirements and does not require any maintenance.

6. Diagnostic Trouble Codes (DTC)

Trouble codes are stored in ECU memory. Any diagnostic trouble codes showing a malfunction that should illuminate the MIL are recorded and stored in the memory. The stored codes identify the malfunctioning system or component as uniquely as possible. These codes are available through the Juniper service tool data link connector and through the Malfunction Indicator Lamp (MIL) system. The ECU also stores codes for conditions that do not turn on the MIL.

Fault Detection

A fault is detected when:

1) The detection conditions are met, so the relevant signals and values are valid and the specified detection criteria are applicable;

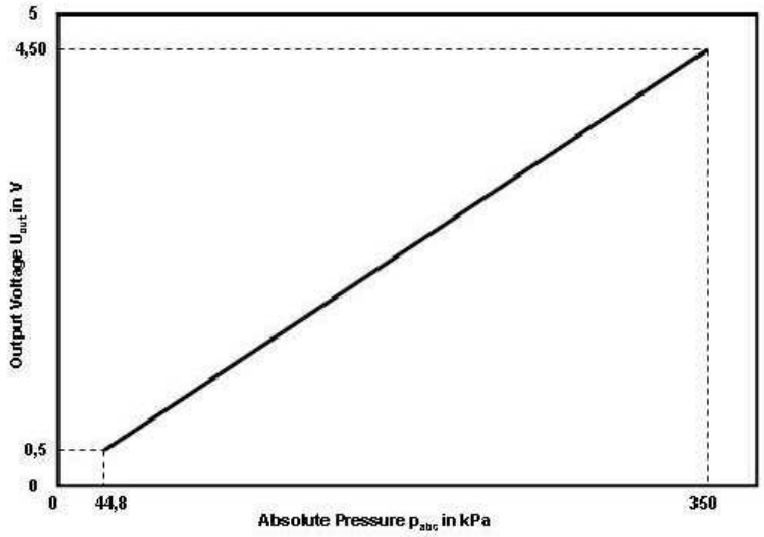
2) The relevant signals and values meet the specified detection criteria. Detection is triggered if criteria are met for longer than the programmable period. Every DTC has a unique programmable period.

Detection Criteria

Most of the DTC specified in this document fall into one of the following two criteria:

- **Circuit faults:** sensors have a voltage output that swings between 0V and the sensor's reference power voltage (5VDC). Within this voltage swing most of the ratiometric sensors work into a narrower operating range. When the output voltage goes outside the operating range the ECU detects a diagnostic fault condition and triggers a specific *CircuitLow* (output voltage lower than operating range) or *CircuitHigh* (output voltage higher than operating range) DTC. This condition is usually caused by electrical short-circuits or open wires.

- **Range faults**: within the operating range of a sensor its reading is assumed correct, but there could be a narrower expected range, bounded by the specific application. If the reading of a sensor goes outside its expected range the ECU triggers a specific *RangeLow* (reading lower than expected range) or *RangeHigh* (reading higher than expected range) DTC.



Example of voltage operating range and diagnostic range of a sensor

Actions

Severe faults trigger specific actions to protect the engine:

- **None:** the fault code is stored in memory for future service reference but does not trigger any specific action. The engine continues to run normally.
- **Turn on MIL**: The MIL lights on. The MIL could be turned on in any working condition (key on, engine running, cranking, etc). The engine continues to run normally.
    - Present DTCs: all faults turn on the MIL immediately after detection or re-spawning (see next paragraph for re-spawning rules), except:
        - Engine over-rev (P0219) does not turn on the MIL;
        - Catalytic efficiency (P0420) does not turn on the MIL;
        - DTCs causing delayed engine shut-down flash the MIL instead of turning it on.
    - Stored DTCs: by EPA requirement, the MIL stays on for 3 consecutive driving cycles after the DTC status turns from Present to Stored.
- **Delayed Engine Shutdown**: the MIL flashes for 30 seconds and then the engine is shut-down.
    - Present DTC: delayed engine shut-down can be triggered only if engine is running.
    - If the shut-down sequence is triggered but the fault condition disappears before its completion the engine shuts-down anyway.

- Stored DTCs: fault conditions stored in previous driving cycles but not currently present do not trigger any action.

- **Engine Shutdown**: the MIL light goes on and the engine is immediately shut-down; stopping ignition and injectors, closing throttle and de-powering the fuel shutoff solenoid valve. This condition also inhibits engine start if the error condition is present during cranking.

    - Present DTC: engine is shut-down immediately after detection or re-spawning (see next paragraph for re-spawning rules).

    - Stored DTCs: fault conditions stored in previous driving cycles but not currently present do not trigger any action.

    - Priority: engine shut-down has priority over delayed engine shut-down due to the fact that it is executed immediately.

Recovery

Some non-critical fault conditions, those that do not require engine shut-down, trigger a recovery strategy, protecting the engine against the fault but limiting performance, and running with un-regulated emissions.

Example 1: in case of MAP circuit high or low DTCs, the MAP reading would no longer be considered valid. The ECU would then revert to “Speed-Density” engine control. What this means is that instead of using the faulty MAP reading a recovery MAP reading is computed using throttle position, engine RPM and barometric pressure. The engine then keeps running with limited performance and un-regulated emissions.

Example 2: Engine coolant temperature (ECT) is too low for stable operation. Activates recovery (disables the foot pedal input), but when the temperature rises again past the threshold the recovery is cancelled and the engine returns to normal operation.

Some implementation rules:
- Present DTCs: recovery is activated as soon as the relevant fault is detected or re-spawned (see next paragraph for re-spawning rules).
- If a recovery is active but the relevant fault condition disappears, the system returns to normal operation (recovery is cancelled).
- Stored DTCs: fault conditions triggered in previous driving cycles but no longer present do not activate a recovery.

Supported Recovery Strategies:

- **Open-loop**: faults of sensors used in closed-loop injection control (or a fault in the injectors themselves) force the ECU to disregard pre and post-cat oxygen sensors feedback. Fuelling is then computed in open-loop and the ECU targets to a default air/fuel ration; the engine continues to run with limited performance and un-regulated emissions.

- **Recovery MAP:** faults of MAP sensor (used in speed-density injection model) are forced to use a virtual recovery MAP reading. MAP is then computed using throttle position, RPM and barometric pressure readings; engine continues to run with limited performance.

- **Limp-home mode:** faults in the Drive-By-Wire chain of the Electronic Throttle Body will limit the throttle plate to a known, almost closed position. Air flow is minimized, resulting in limiting the engine's power output; engine will continue to run with minimum performance.

    - **Default throttle position:** DBW_A and DBW_B outputs are not driven and the electronic throttle body is pushed back by its return spring to the default position (11% TPS).

    - **Limit engine speed:** engine speed is controlled driving DBW_A and DBW_B outputs, that move the Electronic Throttle Body to maintain 1000 RPM.

- **Limit torque to 50%**: engine output is scaled down to 50% of torque.
  For each FPP angle, the torque output is scaled down to 50% of nominal value.
  Engine continues to run with limited output.

Note: RPM limiting is already implemented in the engine control application.

Re-spawning

DTCs and their status are stored in the ECU's memory and re-spawned at each ECU start-up:

- DTC codes and status are re-stored from ECU memory;
- Detection is refreshed immediately after key-on conditions and criteria for each Stored or Present DTC is checked.
- Actions and recovery strategies can be triggered only after the re-spawn process of the relevant DTC is completed, that is, after the detection is refreshed.

For example, if engine oil level is low and the oil pressure switch engages, P0524 DTC is detected, set as Present and the delayed engine shut-down sequence is triggered. During this 30 second sequence the ECU recovers to limited engine speed to protect the engine. The DTC is saved as Present in the ECU's memory.

If the engine is serviced after shut-down, topping-up the oil, at next key-on event P0524 would be restored as Present (has been saved as such). The re-spawning process then evaluates the detection criteria of this fault and finds the engine oil switch in normal condition: P0524 then changes from Present to Stored.

Because Stored DTCs do not trigger any action or recovery the engine can crank and run normally.

Faults that can be detected at key-on are re-spawned with a refreshed status, so they can be fixed (while the engine is off) without the use of the Dealer's service tool. The

engine then runs normally. At all times the relevant DTCs are stored in the ECU's memory and are available for service reference with the diagnostic tool.

Some other critical faults, such as cam and crank position sensors, injectors and ignition coil drivers, can be detected only while the engine is running. Their DTCs are re-spawned to the saved status at key-on: the servicing of these faults does require the use of the Dealer's service tool. If the fault is fixed, the engine will start on the second attempt.

Malfunction Indication Lamp (MIL)

The ECU drives the Malfunction Indicator lamp (MIL) in the dash-board: most DTCs cause this lamp to light-up, signaling the presence of a fault condition to the driver.

MIL management

a. Present DTCs: when detected, some fault conditions require that the MIL is turned on. Some other minor fault conditions instead do not energize the MIL. Please refer to DTC specs.
b. EPA requirement: whenever the air-fuel ratio does not cross stoichiometric fuelling conditions for one minute of intended closed-loop operation, the MIL should go on. This requirement is fulfilled by P2195 and P2196 DTCs.
c. MIL test: when the engine's ignition is in the "key-on" position before starting or cranking, the MIL should be on for 1 second. The MIL should go out after engine starting (or after 3 seconds) if the system detects no fault conditions.
d. Stored DTCs: if the MIL goes on to show a malfunction it must remain on during all later engine operation until servicing corrects the malfunction. If the engine is not serviced, but the malfunction does not recur for three consecutive driving cycles during which the malfunctioning system is evaluated and found to be working properly, the MIL will stay off during later engine operation.

Flash Codes

There is a special diagnostic mode that shows the fault codes directly flashing the MIL:

- To enter code display mode you must turn OFF the ignition key. Now turn ON the key but do not start the engine. As soon as you turn the key to the ON position, cycle the foot pedal by depressing it to the floor and then fully releasing it. You must fully cycle the foot pedal three (3) times within five (5) seconds to enable the code flashing feature of the ECU.
- MIL flashes for each digit of the fault code, with a short pause (2 seconds) between digits and long pauses between different codes (6 sec). Zeros are represented by a single 3 second long flash.
- Starting code: 12
- Trailing code: 12
- Every DTC contains 4 digits
- The code list will continue to repeat until the key is turned OFF.
- Simply turn the key OFF to exit display mode.

Clearing Codes

It is possible to clear all active and stored DTC codes on the ECU using the foot pedal. This is not suggested since the erasing of stored DTCs results in a loss of information

that might provide assistance in troubleshooting issues. It is only possible to view stored DTCs using the Juniper Service Tool and a lap-top computer.

- To clear the ECU memory of all DTCs (past and present) you must turn OFF the ignition key. Now turn ON the key but do not start the engine. As soon as you turn the key to the ON position, cycle the foot pedal by depressing it to the floor and then fully releasing it. You must fully cycle the foot pedal ten times within ten seconds.

Driving Cycle Definition

The driving cycle is defined as the following sequence:
- key on
- engine on (crank signal present)
- key off

SUPPORTED DTCS

This list summarizes the following:

- **DTC:** each fault condition triggers a different J2012 compliant, 5-digit code.
- **DTC naming:** J2012 compliant name of fault condition (shown in Service-tool software).
- **Thresholds:** programmable thresholds for detection criteria, if any.
- **Possible causes:** quick list of possible conditions that trigger the fault code.
- **Action:** list of actions triggered by the DTC, if any.
- **Recovery:** list of recovery strategy activated by the DTC, if any.

DTC	DTC naming	Thresholds	Possible causes	Action	Recovery
P0117	Engine coolant temperature circuit low	Programmable voltage	Broken wirings or defective sensor	Turn on MIL	default to 80°C
P0118	Engine coolant temperature circuit high	Programmable voltage	Broken wirings or defective sensor	Turn on MIL	default to 80°C
P0126	Insufficient coolant temperature for stable operation	Programmable voltage	Engine working at out-of-spec temperature	Flash MIL	Disable FPP
P0217	Engine coolant over temperature condition	Programmable voltage	Engine over-heating and working out-of-spec	Delayed engine shut-down	Limit engine speed to 1000 RPM
P0341	Camshaft position sensor “A” circuit range / performance		No signal while engine rotating or cranking. Broken wirings or defective sensor.	Engine shut down (inhibits cranking)	
P0336	Crankshaft position sensor “A” circuit range / performance		No signal while engine rotating or cranking. Broken wirings or defective sensor.	Engine shut down (inhibits cranking)	
P0122	Throttle position sensor “A” circuit low	Programmable voltage	Throttle Position Sensor 1 failure, shorted to ground or open circuit; Broken wirings or defective sensor	Turn on MIL	Limp home at default throttle position
P0123	Throttle position sensor “A” circuit high	Programmable voltage	Throttle Position Sensor 1 failure or shorted to power; Broken wirings or defective sensor	Turn on MIL	Limp home at default throttle position
P0222	Throttle position sensor “B” circuit low	Programmable voltage	Throttle Position Sensor 2 failure, shorted to ground or open circuit ;	Turn on MIL	Limp home at default throttle position

DTC	DTC naming	Thresholds	Possible causes	Action	Recovery
			Broken wirings or defective sensor		
P0223	Throttle position sensor “B” circuit high	Programmable voltage	Throttle Position Sensor 2 failure or shorted to power ; Broken wirings or defective sensor	Turn on MIL	Limp home at default throttle position
P2109	Throttle position sensor “A” minimum stop performance	Learned closed position	TPS1 lower than learned closed position	Turn on MIL	Limp home at default throttle position
P2113	Throttle position sensor “B” minimum stop performance	Learned closed position	TPS2 lower than learned closed position	Turn on MIL	Limp home at default throttle position
P2163	Throttle position sensor “A” maximum stop performance	Learned WOT position	TPS1 higher than learned closed position	Turn on MIL	Limp home at default throttle position
P2164	Throttle position sensor “B” maximum stop performance	Learned WOT position	TPS1 higher than learned closed position	Turn on MIL	Limp home at default throttle position
P2135	Throttle pedal position sensors “A” / “B” voltage correlation		Throttle Position Sensors out of track; Defective electronic throttle body. TPS sensors voltages differ more than expected.	Turn on MIL	Limp home at default throttle position
P0638	Throttle actuator control range/performance		Throttle plate (butterfly valve) is sticking inside the throttle bore or return spring is weak	Engine Shutdown	
P2100	Throttle actuator control motor open		DBW_A or DBW_B open load. Broken wirings or defective ECU.	Engine Shutdown	
P2103	Throttle actuator control motor circuit high		DBW_A or DBW_B outputs are shorted to battery voltage. Broken wirings or defective ECU.	Engine Shutdown	
P2102	Throttle actuator control motor circuit low		DBW_A or DBW_B outputs are shorted to ground. Broken wirings or defective ECU.	Engine Shutdown	
P0107	Manifold absolute pressure circuit low input	Programmable voltage	Manifold absolute pressure sensor disconnected, shorted to GND or open circuit; Broken wirings or defective sensor	Turn on MIL	Recovery MAP
P0108	Manifold absolute pressure circuit high input	Programmable voltage	Manifold absolute pressure sensor failure or short to power; Broken wirings or defective sensor	Turn on MIL	Recovery MAP
P1101	Manifold absolute pressure too low	% of atmospheric pressure	Manifold absolute pressure lower than expected	Turn on MIL	
P1102	Manifold absolute pressure too high	% of atmospheric pressure	Manifold absolute pressure higher than expected	Turn on MIL	
P2228	Barometric pressure circuit low	Programmable voltage	Barometric pressure sensor disconnected, shorted to GND or open circuit; Broken wirings or defective sensor	Turn on MIL	
P2229	Barometric pressure circuit high	Programmable voltage	Barometric pressure sensor failure or short to power; Broken wirings or defective sensor	Turn on MIL	
P1103	Barometric pressure too high	Programmable pressure (1100mbar)	Higher than expected	Turn on MIL	
P0129	Barometric pressure too low	Programmable pressure (500mbar)	Lower than expected	Turn on MIL	
P0112	Intake air temperature sensor 1 circuit low	Programmable voltage	Intake Air Temperature Sensor failure or shorted to GND; Broken wirings or defective sensor	Turn On MIL	Set to default 30°C
P0113	Intake air temperature sensor 1 circuit high	Programmable voltage	Intake Air Temperature Sensor disconnected, short to power or open circuit; Broken wirings or defective sensor	Turn On MIL	Set to default 30°C
P1104	Intake air temperature too low		IAT reading out of expected range; engine working out of spec	Turn On MIL	
P0127	Intake air temperature too high		IAT reading out of expected range;	Turn On MIL	

DTC	DTC naming	Thresholds	Possible causes	Action	Recovery
			engine working out of spec		
P0524	Engine oil pressure too low		Engine oil pressure switch is on, because of low level.	Delayed Engine shutdown & flash optional oil lamp	Limit engine speed to 1000RPM
P0562	System voltage low	Programmable voltage (10V)	Battery voltage too low for defined period	Turn On MIL	
P0563	System voltage high	Programmable voltage (16V)	Battery voltage too high for defined period, defective alternator	Turn On MIL	
P0642	Sensor reference voltage “A” circuit low	Programmable voltage	Sensors reference voltage too low; Defective ECU or over-load	Engine shutdown	
P0643	Sensor reference voltage “A” circuit high	Programmable voltage	Sensors reference voltage too high; Defective ECU	Engine shutdown	
P0652	Sensor reference voltage “B” circuit low	Programmable voltage	Sensors reference voltage too low; Defective ECU or over-load	Engine shutdown	
P0653	Sensor reference voltage “B” circuit high	Programmable voltage	Sensors reference voltage too high; Defective ECU	Engine shutdown	
P0698	Sensor reference voltage “C” circuit low	Programmable voltage	Sensors reference voltage too low; Defective ECU or over-load	Engine shutdown	
P0699	Sensor reference voltage “C” circuit high	Programmable voltage	Sensors reference voltage too high; Defective ECU	Engine shutdown	
P0219	Engine over-speed	Programmable RPM	Engine over-revving	No action	
P2122	Pedal position sensor “D” circuit low input	Programmable voltage	Foot-pedal position sensor 1 disconnected, shorted to GND or open circuit ; Broken wirings or defective pedal assy.	Turn On MIL	Limp home at default throttle position
P2127	Pedal position sensor “E” circuit low input	Programmable voltage	Foot-pedal position sensor 2 disconnected, shorted to GND or open circuit ; Broken wirings or defective pedal assy.	Turn On MIL	Limp home at default throttle position
P2123	Pedal position sensor “D” circuit high input	Programmable voltage	Foot-pedal position sensor 1 failure or shorted to power ; Broken wirings or defective pedal assy.	Turn On MIL	Limp home at default throttle position
P2128	Pedal position sensor “E” circuit high input	Programmable voltage	Foot-pedal position sensor 2 failure or shorted to power; Broken wirings or defective pedal assy.	Turn On MIL	Limp home at default throttle position
P2138	Pedal position sensor “D” / “E” voltage correlation		Foot-pedal position sensors out of track ; Intermittent connections or defective pedal assy.	Turn On MIL	Limp home at default throttle position
P0005	Fuel shutoff valve “A” control circuit / open	Programmable currents (open-circuit and short-circuit)	Fuel shutoff valve 1 failure, disconnected or shorted to ground; Broken wirings, defective solenoid or defective ECU.	Turn On MIL	
P1001	Fuel shutoff valve “B” control circuit / open	Programmable currents (open-circuit and short-circuit)	Fuel shutoff valve 2 failure, disconnected or shorted to ground; Broken wirings, defective solenoid or defective ECU.	Turn On MIL	
P1002	Fuel shutoff valve “C” control circuit / open	Programmable currents (open-circuit and short-circuit)	Fuel shutoff valve 3 failure, disconnected or shorted to ground; Broken wirings, defective solenoid or defective ECU.	Turn On MIL	
P0171	System too lean	Programmable %	KFLamAd lower than expected (0,75): Engine, injectors or pressure reducer out of spec.	Turn On MIL	Open-loop Limit torque 50%
P0172	System too rich	Programmable %	KFLamAd higher than expected (1,25): Engine, injectors or pressure reducer out of spec.	Turn On MIL	Open-loop Limit torque 50%
P2195	O2 sensor signal stuck lean bank 1 sensor 1	Programmable duration and voltage	Pre-cat O_2 sensor too lean for too long time (60 secs as per EPA).	Turn On MIL	Open-loop Limit torque 50%

DTC	DTC naming	Thresholds	Possible causes	Action	Recovery
P2196	O2 sensor signal stuck rich bank 1 sensor 1	Programmable duration and voltage	Pre-cat O_2 sensor too rich for too long time (60 secs as per EPA).	Turn On MIL	Open-loop Limit torque 50%
P0131	O2 sensor circuit low voltage bank 1 sensor 1	Programmable voltage	Pre-cat O_2 sensor failure or shorted to ground	Turn On MIL	Open-loop Limit torque 50%
P0132	O2 sensor circuit high voltage bank 1 sensor 1	Programmable voltage	Pre-cat O_2 sensor failure or shorted to power	Turn On MIL	Open-loop Limit torque 50%
P0137	O2 sensor circuit low voltage bank 1 sensor 2	Programmable voltage	Post-cat O_2 sensor disconnected or shorted to ground	Turn On MIL	
P0138	O2 sensor circuit high voltage bank 1 sensor 2	Programmable voltage	Post-cat O_2 sensor failure or shorted to power	Turn On MIL	
P0135	O2 Sensor Heater circuit bank 1 sensor 1		Short circuit to battery or open load	Turn On MIL	
P0141	O2 Sensor Heater circuit bank 1 sensor 2		Short circuit to battery or open load	Turn On MIL	
P0192	Fuel rail pressure sensor circuit low	Programmable voltage	Broken wirings or defective sensor	Turn on MIL	Default to PresIntake + 1700 mbar
P0193	Fuel rail pressure sensor circuit high	Programmable voltage	Broken wirings or defective sensor	Turn on MIL	Default to PresIntake + 1700 mbar
P0088	Fuel rail / system pressure too high	3000mbar	Fuel absolute pressure higher than expected	Shutoff solenoid valve	
P0087	Fuel rail / system pressure too low	1700mbar	Fuel absolute pressure lower than expected	Turn on MIL	
P0182	Fuel temperature sensor “A” circuit low	Programmable voltage	Fuel Temperature Sensor failure or shorted to GND; Broken wirings or defective sensor	Turn On MIL	default to 40°C
P0183	Fuel temperature sensor “A” circuit high	Programmable voltage	Fuel Temperature Sensor disconnected, short to power or open circuit; Broken wirings or defective sensor	Turn On MIL	Default to 40°C
P1105	Fuel temperature too low	Programmable temperature	FRT reading out of expected range; engine working out of spec	Turn On MIL	
P0168	Fuel temperature too high	Programmable temperature	FRT reading out of expected range; engine working out of spec	Turn On MIL	
P0261	Cylinder 1 injector circuit low	Programmable current	Short circuit to ground or open load	Delayed Engine shutdown	Open loop Limit torque to 50%
P0262	Cylinder 1 injector circuit high	Programmable current	Short circuit to battery	Delayed Engine shutdown	Open loop Limit torque to 50%
P0263	Cylinder 2 injector circuit low	Programmable current	Short circuit to ground or open load	Delayed Engine shutdown	Open loop Limit torque to 50%
P0264	Cylinder 2 injector circuit high	Programmable current	Short circuit to battery	Delayed Engine shutdown	Open loop Limit torque to 50%
P0265	Cylinder 3 injector circuit low	Programmable current	Short circuit to ground or open load	Delayed Engine shutdown	Open loop Limit torque to 50%
P0266	Cylinder 3 injector circuit high	Programmable current	Short circuit to battery	Delayed Engine shutdown	Open loop Limit torque to 50%
P0267	Cylinder 4 injector circuit low	Programmable current	Short circuit to ground or open load	Delayed Engine shutdown	Open loop Limit torque to 50%
P0268	Cylinder 4 injector circuit high	Programmable current	Short circuit to battery	Delayed Engine shutdown	Open loop Limit torque to 50%
P0380	Glow plug / heater circuit “A”	Programmable current	Broken wirings, defective heater or defective ECU	Turn On MIL	
P0420	Catalyst system efficiency below threshold	Programmable threshold	Pre and post-cat lambdas failed the checking algorithm (5228335)	None (just store the code)	
P0069	Manifold absolute pressure / Barometric pressure correlation	Programmable percentage	MapSignal <> RecoveryMap; defective or clogged sensor	Turn on MIL	Recovery MAP
P0094	Fuel system leak detected – Small leak	Programmable time, min and max pressure drop	Leakage detected in low-pressure circuit. ECU performs leakage test after engine shutdown (long time window,	Turn on MIL	

DTC	DTC naming	Thresholds	Possible causes	Action	Recovery
			60 sec).		
P0093	Fuel system leak detected – Large leak	Programmable time and min pressure drop	Leakage detected in low-pressure circuit. ECU performs large leakage test after engine shut-down (short time window, 10sec).	Engine shut-down (inhibits cranking)	
P2560	Engine coolant level low		Engine coolant level switch engaged	Delayed Engine shutdown	Limit engine speed to 1000 RPM

7. General Trouble Shooting

General checks to perform prior to initiating any of the trouble shooting actions listed in this section:

Fuel level	Check that the LPG tank is connected, contains fuel, and the tank valve is open.
Fuses	Check the continuity of all fuses in the main vehicle fuse box.
Oil level	Check that sufficient oil is in the engine, and that engine oil is in good condition.
Harness	Check that harness is connected to ECU, and inspect for any damage including tears, melted wires, and abrasion.
Electrical connections	Check that all sensors are connected, and that connectors are free of corrosion.
Fluid Leaks	General inspection of engine components and surrounding area for leaks of fluids.
Filters (air and fuel)	Check that all air and fuel filters are in good condition. Replace dirty or clogged filters.

Engine cranks but will not start

Probable Cause	**Recommended Action**
Tank valve is closed	Rotate tank valve counter clockwise and retry starting.
Tank excess flow valve is closed	Reset excess flow valve in LPG tank. Close the liquid shut-off valve, wait for a “click” sound, and then slowly reopen the liquid valve.
LPG tank is empty	Replace with full tank and retry starting.
Fuel shutoff valve is closed	Check connector for 12 V drop across terminals at key on, replace valve if voltage drop present and valve not opening.
Diagnostic Trouble Code	If MIL is on, record the codes being displayed and attend to any errors reported.
Ignition system malfunction	Check for spark at coil output. If good spark: Inspect and replace spark plugs if needed. If poor/no spark: Check resistance across coil terminals is within specification. Check pin 5 of spark harness connector for battery voltage at key on. Inspect and replace ignition power transistors if necessary.
General fuel system malfunction	Inspect fuel rail for leaks and/or blockages, replace if necessary. Inspect and replace any plugged or damaged fuel and

	injection hoses/nozzles. Check rail fuel pressure is greater than 1800 mBar absolute at key on. Inspect and replace Liquid LPG filter if necessary Inspect and replace Gaseous LPG filter if necessary
Fuel line is plugged or disconnected	Inspect and connect/replace if necessary.
Crankshaft position is not detected	Check continuity of harness, replace sensor if harness passes check.
Camshaft position is not detected	Check continuity of harness, replace sensor if harness passes check.
No oil pressure	If engine starts and stalls after about 5 seconds: Check oil level. Check oil pressure sensor connection. Check oil pressure sensor.
TMAP Sensor failure	Check sensor is connected. Check harness continuity. Check manifold pressure = barometric pressure ± 15 mBar at key on, replace sensor if not. Check intake temperature > ambient air temperature, replace sensor if not.
General ECU malfunction	Check battery voltage is greater than 8V. Check relay power source at key on. Check power source at ECU connector and that harness is connected. Re-download firmware and calibration to ECU using dealer service tool. Confirm MIL comes on at key on, replace ECU if it does not.

Engine does not provide expected power output, slow to accelerate, stalls when lifting load

Probable Cause	**Recommended Action**
Fuel Level Low	Inspect tank fuel level, replace tank if necessary.
Diagnostic Trouble Code	If MIL is on, run diagnostic procedure outlined in Section 6. Attend to any errors reported.
General Fuel system malfunction	Inspect and replace any plugged or damaged injection hoses/nozzles. Inspect fuel rail for leaks and/or blockages, replace if necessary. Check liquid and gaseous fuel filters, replace if clogged or dirty. Check rail fuel pressure is greater than 1800 mBar at key on using service tool Check 0.8< KFLamAd <1.2 with service tool at all

	engine conditions.
Oxygen sensor malfunction	Check harness connection and continuity. Check pre and post catalyst O2 sensor voltage averages 300 to 600 mV using dealer service tool, replace sensor if not.
Ignition system malfunction	Inspect and replace spark plugs if needed. Check base ignition timing. Check that ignition coils are properly connected Check that all power transistors are properly connected
Injector rail failure	Check that 0.8 < KFLamAd < 1.2 at idle and full throttle, replace rail if not and recheck. Inspect rail for damage and blockages, replace if necessary.
Regulator failure	Check that intake pressure reference is connected without leaks or damage. Check that rail fuel pressure is > 1300 mBar at Idle. Check that rail fuel pressure is > 1600 mBar at Full throttle in neutral.
Inlet or Exhaust System Restriction	Inspect intake air filter and replace if clogged/dirty. Check exhaust backpressure pre catalyst is within specification. Inspect exhaust catalyst and replaced if clogged or damaged.
Base engine issue	Refer to engine troubleshooting guide.
ECU software issue	Upload newest firmware and calibration using service tool.
TMAP Sensor failure	Check sensor is connected. Check harness continuity. Check manifold pressure = barometric pressure +- 10 mBar at key on using service tool, replace sensor if not. Check intake temperature > ambient air temperature using service tool, replace sensor if not.
Throttle Body Failure	Check that throttle fully opens and closes immediately after turning engine off Check that TAobj = Throttle angle using service tool
Transmission Malfunction	Refer to transmission troubleshooting guide.

Engine speed hunting at idle and other speed and load conditions

Probable Cause	**Recommended Action**
Fuel Level Low	Inspect tank fuel level, replace tank if necessary.
Incorrect coolant temperature	Check 80 < Water temp < 105 after engine is warmed. If not then: Check coolant level. Check for loose or damaged water pump belt.

	Check for restricted air or water flow through radiator. Bleed air from coolant system at regulator. Replace thermostat. Check that regulator is not passing gaseous fuel into coolant line
Diagnostic Trouble Code	If MIL is on, run diagnostic procedure outlined in Section 6. Attend to any errors reported.
Fuel system malfunction	Check rail fuel pressure is > 1800 mBar at key on. Check 0.8< KFLamAD <1.2 at all engine conditions. Inspect and replace any plugged or damaged injection hoses/nozzles. Inspect fuel rail for leaks and/or blockages, replace if necessary. Check liquid and gaseous fuel filters, replace if clogged or dirty.
Oxygen sensor malfunction	Check harness connection and continuity. Check pre and post catalyst O2 sensor voltage. averages 300 to 600 mV using dealer service tool.
Ignition system malfunction	Inspect and replace spark plugs if needed. Check base ignition timing. Check that ignition coils are properly connected Check that all power transistors are properly connected
TMAP Sensor failure	Check sensor is connected. Check harness continuity. Check manifold pressure = barometric pressure +- 10 mBar at key on using service tool, replace sensor if not. Check intake temperature > ambient air temperature using service tool, replace sensor if not.
Throttle Body Failure	Check if throttle fully opens and closes immediately after engine shutdown. If not, replace with new throttle body and test performance.

Engine backfires

Probable Cause	**Recommended Action**
Diagnostic Trouble Code	If MIL is on, run diagnostic procedure outlined in Section 6. Attend to any errors reported.
Fuel system malfunction	Check rail fuel pressure is > 1800 mBar at key on. Check 0.8< KFLamAd <1.2 at all engine conditions. Inspect and replace any plugged or damaged injection hoses/nozzles. Inspect fuel rail for leaks and/or blockages, replace if necessary. Check liquid and gaseous fuel filters, replace if clogged or dirty.

Oxygen sensor malfunction	Check harness connection and continuity. Check pre and post catalyst O2 sensor voltage averages 300 to 600 mV using dealer service tool.
Ignition system malfunction	Inspect and replace spark plugs if needed. Check that ignition coils are properly connected Check that all power transistors are properly connected Check base timing. Check resistance across coil terminals is within specification.
TMAP Sensor failure	Check sensor is connected. Check harness continuity. Check manifold pressure = barometric pressure +- 10 mBar at key on using service tool, replace sensor if not. Check intake temperature > ambient air temperature using service tool, replace sensor if not.
Exhaust system malfunction	Check for exhaust leaks. Check for blown out/damaged muffler.
Base engine malfunction	Check cylinder compression, look for valve leakage.

Engine knocking

Probable Cause	**Recommended Action**
Diagnostic Trouble Code	If MIL is on, run diagnostic procedure outlined in Section 6. Attend to any errors reported.
Incorrect coolant temperature	Check 80 < Water temp < 105 after engine is warmed. If not then: Check coolant level. Check for loose or damaged water pump belt. Check for restricted air or water flow through radiator. Bleed air from coolant system at regulator. Check that regulator is not passing gaseous fuel into coolant line Replace thermostat.
Engine Oil condition	Check oil level and refill if low or in poor condition
Poor fuel quality	Replace tank with another source and recheck.
Carbon deposits in combustion chamber	Treat engine with combustion chamber cleaner.
Fuel system malfunction	Check rail fuel pressure is > 1800 mBar at key on. Check 0.8< KFLamAd <1.2 at all engine conditions. Inspect and replace any plugged or damaged injection hoses/nozzles. Inspect fuel rail for leaks and/or blockages, replace if necessary.

	Check liquid and gaseous fuel filters, replace if clogged or dirty.
Oxygen sensor malfunction	Check harness connection and continuity. Check pre and post catalyst O2 sensor voltage averages 300 to 600 mV using dealer service tool.
Ignition system malfunction	Check base timing. Spark plugs heat range too low, replace with higher heat range.
TMAP Sensor failure	Check sensor is connected to harness. Check harness continuity. Check manifold pressure = barometric pressure +- 10 mBar at key on using service tool, replace sensor if not. Check intake temperature > ambient air temperature using service tool, replace sensor if not.
Base engine issue	Check cylinder compression is within specification Refer to engine troubleshooting guide.

Engine run-on after shut down

Probable Cause	**Recommended Action**
Leaky injectors	Investigate injectors as per injector maintenance instructions. Run injector leakage active diagnostic using dealer service tool
Combustion Hot spots	Refer to base engine trouble shooting guide.
Ignition Switching	Check that power to ECU is shut off at key off.

Engine misfires

Probable Cause	**Recommended Action**
Fuel system malfunction	Inspect fuel rail for leaks and/or blockages, replace if necessary. Inspect and replace any plugged or damaged injection hoses/nozzles. Check rail fuel pressure is > 1800 Bar at key on. Check 0.8< KFLamAd <1.2 at all engine conditions. Check liquid and gaseous fuel filters, replace if clogged or dirty.
Oxygen sensor malfunction	Check harness connection and continuity. Check pre and post catalyst O2 sensor voltage averages 300 to 600 mV using dealer service tool.
Ignition system malfunction	Inspect and replace spark plugs if needed. Check that ignition coils are properly connected Check that all power transistors are properly connected

	Check resistance across coil terminals is within specification.
TMAP Sensor failure	Check sensor is connected. Check harness continuity. Check manifold pressure = barometric pressure +- 10 mBar at key on using dealer service tool, replace sensor if not. Check intake temperature > ambient air temperature using dealer service tool, replace sensor if not.

Poor fuel economy

Probable Cause	Recommended Action
Oxygen sensor malfunction	Check harness connection and continuity. Check pre and post catalyst O2 sensor voltage. averages 300 to 600 mV using dealer service tool.
Fuel system malfunction	Inspect fuel rail for leaks and/or blockages, replace if necessary. Check liquid and gaseous fuel filters, replace if clogged or dirty. Check rail fuel pressure is > 1800 mBar at key on. Check 0.8< KFLamAd <1.2 at all engine conditions. Inspect and replace any plugged or damaged injection hoses/nozzles.
Ignition system malfunction	Inspect and replace spark plugs if needed. Check that ignition coils are properly connected Check that all power transistors are properly connected Check resistance across coil terminals is within specification.
Incorrect coolant temperature	Check 80 < Water temp < 105 after engine is warmed. If not then: Check coolant level. Check for loose or damaged water pump belt. Check for restricted air or water flow through radiator. Bleed air from coolant system at regulator. Check that regulator is not passing gaseous fuel into coolant line Replace thermostat.
TMAP Sensor failure	Check sensor is connected. Check harness continuity. Check manifold pressure = barometric pressure +-10 mBar at key on using service tool, replace sensor if not. Check intake temperature > ambient air temperature using service tool, replace sensor if not.
Base engine issue	Refer to engine troubleshooting guide for possible

	problem resulting in poor compression.
Inlet or exhaust system restriction	Inspect intake air filter and replace if clogged/dirty. Check exhaust backpressure pre catalyst is within specification. Inspect exhaust catalyst and replaced if clogged or damaged.

High idle speed (above the set point of 750 rpm)

Probable Cause	Recommended Action
Incorrect coolant temperature	Check 80 < Water temp < 105 after engine is warmed. If not then: Check coolant level. Check for loose or damaged water pump belt. Check for restricted air or water flow through radiator. Bleed air from coolant system at regulator. Check that regulator is not passing gaseous fuel into coolant line Replace thermostat.
Throttle Body Failure	Check that throttle opens fully and closes immediately following engine shutdown. If not, replace with new throttle body and retest.

Exhaust emissions seem excessive

Probable Cause	Recommended Action
Incorrect coolant temperature	Check 80 < Water temp < 105 after engine is warmed. If not then: Check coolant level. Check for loose or damaged water pump belt. Check for restricted air or water flow through radiator. Bleed air from coolant system at regulator. Replace thermostat.
Fuel system malfunction	Inspect and replace any plugged or damaged injection hoses/nozzles. Inspect fuel rail for leaks and/or blockages, replace if necessary. Check rail fuel pressure is > 1800 mBar at key on. Check 0.8< KFLamAd <1.2 at all engine conditions. Check liquid and gaseous fuel filters, replace if clogged or dirty.
Oxygen sensor malfunction	Check harness connection and continuity. Check pre and post catalyst O2 sensor voltage averages 300 to 600 mV using dealer service tool.

Ignition system malfunction	Inspect and replace spark plugs if needed. Check that ignition coils are properly connected Check that all power transistors are properly connected Check resistance across coil terminals is within specification.
TMAP Sensor failure	Check sensor is connected. Check harness continuity. Check manifold pressure = barometric pressure +- 10 mBar at key on using service tool, replace sensor if not. Check intake temperature > ambient air temperature using service tool, replace sensor if not.
Exhaust system malfunction	Check for exhaust leaks. Check pre catalyst exhaust pressure is within specification. Check for damaged catalyst.

8. TROUBLE SHOOTING BY DTC

To use this section you must first obtain a trouble code, either by use of the MIL or the service tool. Once you have a trouble code, find the corresponding code from this section and follow the written instructions. Once the problem is detected and fixed, the code can be cleared as per the instructions in Section 6.

DTC 5: Fuel shutoff valve "A" control circuit / open

Possible Causes
A. Fuel shutoff valve disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Fuel shutoff valve defective
E. ECU defective

1. Is the fuel shutoff valve connected?
   -Yes: Go to 2.
   -No: Reconnect and test again
2. Disconnect EV RP connector (shutoff valve on reducer) and test for continuity between connector terminals and chassis ground.
   -No Continuity on Pin 2, or Pin 1 with Key Off: Go to 3.
   -Continuity on Pin 1 or Pin 2: Locate and rectify short to ground.
3. Test for continuity between EV RP connector Pin 1 and ECU Pin O1, and EV RP connector Pin 2 with ECU Pin P4 and Main Relay Receptacle A Pin 87.
   -Continuity: Go to 4.
   -No Continuity: Locate and rectify break in harness wiring
4. Test resistance between terminal A and B on fuel shutoff valve.
   -13 +/- 3 ohm: Go to 5.
   -Resistance out of specification: Replace fuel shutoff valve
5. Test fuel shutoff valve connector Pin 2 voltage output at within 5 seconds of Key On.
   - EV RP connector Pin 2 is battery voltage: Go to 6.
   - EV RP connector Pin 2 is not battery voltage:
     - Check ECU pin P4 has battery voltage with key-on.
     - If P4 has battery voltage: Check wire harness for damage between ECU pin P4 and EV RP connector Pin 2.
     - If P4 does not have battery voltage: Inspect and replace main engine relay A that sources VBAT and feeds current to ECU Pin
6. Test fuel shutoff valve connector Pin1 voltage at Key On.
   -Pin 1 is not continuous with Chassis ground:
     - Check ECU main ground connections
     - Replace ECU diagnosed as faulty

DTC 69: Manifold absolute pressure / Barometric pressure correlation

Possible Causes
A. Manifold pressure sensor disconnected
B. Harness is shorted to ground

C. Harness wires are broken damaged
D. MAP Sensor is defective
E. ECU pressure equalization port is plugged/clogged
F. Barometric pressure sensor is defective
G. ECU defective

1. Is the T-MAP sensor connected to harness?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Is the pressure equalization port on the ECU housing clear of obstruction/debris?
    -Yes: Go to 3.
    -No: Clean pressure equalization port and retest
3. Test for continuity between harness connector Pins and Chassis Ground with ECU in key-off mode.
    -Only Pin 4 is continuous: Go to 4.
    -Pins 1, 2 or 3 are continuous: Locate and rectify short in harness
4. Test harness continuity.
    Continuities are T-MAP Connector Pin 1 --- ECU C1
    T-MAP Connector Pin 2 --- ECU C3
    T-MAP Connector Pin 3 --- ECU C2
    T-MAP Connector Pin 4 --- ECU C4: Go to 5.
    Anything other than above: Locate and Rectify harness damage. Look for cuts, nicks and pinched or melted wires.
5. Test manifold pressure sensor output with engine key-on but not rotating (0 RPM).
    -Manifold pressure is reported in Juniper service tool and should equal actual atmospheric* pressure +/- 50 mBar at Key On: Go to 6.
    -If the manifold pressure is not equal to atmospheric pressure at Key On: Replace MAP sensor
    - *For reference, check local weather report
6. Test ECU voltage outputs at Key On.
    -Connector T-MAP Connector Pin 1 is 5 +/- 0.5V
    T-MAP Connector Pin 2 is 5 +/- 0.5V
    T-MAP Connector Pin 3 is 5 +/- 0.5V
    T-MAP Connector Pin 4 is 0 +/- 0.5V: Nominal
    -Voltage outputs out of specification: Replace ECU

DTC 87: Fuel rail / system pressure too low

Possible Causes
A. Fuel level very low or fuel is extremely cold
B. Fuel rail pressure sensor (PRAIL) disconnected
C. Harness shorted or damaged
D. Liquid or gaseous fuel filters are dirty
E. Fuel regulator out of specification (causing abnormally low pressure)
F. PRAIL sensor defective
G. ECU defective

1. Check fuel supply pressure.
    - Fuel tank shut-off valve must be open.

-The LPG tank temperature must be sufficient to create adequate vapor pressure (typically above -10 °C or + 14 °F for good quality propane).
-Fuel tank is not empty: Go to 2.
-Fuel tank empty: Replace with a full tank and retest

2. Is the PRAIL sensor connected?
-Yes: Go to 3.
-No: Reconnect and test
3. Test PRAIL harness for short to ground with Key Off for at least 25 seconds.
-Only TP Rail Pin 1 is continuous with chassis ground: Go to 4.
-Pins other than 1 are continuous with ground: Locate and rectify harness short
4. Test Continuity of harness in Key off mode after at least 25 seconds.
-Continuities are TP Rail connector Pin 1 --- ECU C4
TP Rail connector Pin 2 --- ECU E1
TP Rail connector Pin 3 --- ECU D1
TP Rail connector Pin 4 --- ECU C3: Go to 5.
-Anything other than above: Locate and rectify damage in harness
5. Test voltage outputs from ECU at PRAIL connector while disconnected at Key On
-Voltages are TP Rail connector Pin 1 --- Chassis ground
TP Rail connector Pin 2 --- 5 +/- 0.5V
TP Rail connector Pin 3 --- 5 +/- 0.5V
TP Rail connector Pin 4 --- 5 +/- 0.5V: Go to 6.
-Voltages are out of specification: Replace ECU
6. Test Fuel pressure using Juniper service tool with regulator shutoff valve disconnected, and fuel line disconnected from fuel rail.
-Reported absolute fuel pressure is equal to local atmospheric pressure +/- 100 mBar: Go to 7.
-Reported absolute fuel pressure is not equal to atmospheric pressure +/- 100 mBar: Replace PRAIL sensor
7. Test Fuel pressure at Idle using Juniper Service tool.
-Reported fuel pressure relative to manifold absolute pressure is less than 1100 mBar: Replace gaseous fuel filter, if problem persists replace regulator.

DTC 88: Fuel rail / system pressure too high

This diagnostic checks for excessive fuel rail pressure.

Possible Causes
A. Fuel rail pressure sensor (PRAIL) disconnected
B. Harness shorted or damaged
C. PRAIL sensor defective
D. Fuel regulator defective
D. ECU defective

1. Is the PRAIL sensor connected?
-Yes: Go to 2.
-No: Reconnect and test
2. Test harness for short to ground with Key Off for at least 25 seconds.
-Only Pin 1 is continuous with chassis ground: Go to 3.
-Pins other than 1 are continuous with ground: Locate and rectify harness short
3. Test Continuity of harness in Key Off mode after at least 25 seconds.

-Continuities are TP Rail connector Pin 1 --- ECU C4
TP Rail connector Pin 2 --- ECU E1
TP Rail connector Pin 3 --- ECU D1
TP Rail connector Pin 4 --- ECU C3: Go to 4.

-Anything other than above: Locate and rectify damage in harness

4. Test voltage outputs from ECU at PRAIL connector while disconnected and Key On

-Voltages are TP Rail connector Pin 1 --- Chassis ground
TP Rail connector Pin 2 --- 5 +/- 0.5V
TP Rail connector Pin 3 --- 5 +/- 0.5V
TP Rail connector Pin 4 --- 5 +/- 0.5V: Go to 5.

-Voltages are out of specification: Replace ECU

5. Test Fuel pressure using Juniper service tool with regulator shutoff valve disconnected, and fuel line disconnected from fuel rail.

-Reported absolute fuel pressure is equal to local atmospheric +/- 100 mBar: Go to 6.

-Reported absolute fuel pressure is not equal to local atmospheric +/- 100 mBar: Replace PRAIL sensor

6. Test Fuel pressure at Key ON using Juniper service tool with regulator shutoff valve and all fuel lines connected.

-Reported fuel pressure is higher than 3000 mBar (absolute): Replace regulator

DTC 93: Fuel system leak detected – Large leak

This diagnostic looks for leaks between the regulator and the injector fuel rail. It can detect gross leaks in various connections / hoses and even minute seat leaks in the injectors as they age and wear.

Possible Causes

A. Disconnected / loose fuel line or fittings
B. Damaged/leaking fuel line
C. Damaged/leaking fuel filter
D. Damaged/leaking fuel rail and injectors
E. Damaged/leaking regulator

1. Check that all fuel lines are connected.

-Yes: Go to 2.

-No: Reconnect and retest

2. Check fuel lines between regulator and fuel rail, including fuel filter, for gas leaks using a soap/water solution with Key On.

-No visible leaks or bubbles: Go to 3.

-Visible leaks/bubbles: Replace damaged fuel hose components, seals, or clean and tighten loose connections. .

3. Check fuel rail for external leaks using soap/water solution with Key On.

-No obvious leaks: Go to 4.

-Visible leaks/bubbles: Clean and tighten loose components, replace fuel rail if necessary

4. Check fuel rail for internal leaks by disconnecting fuel injection hoses (to the intake ports) from fuel rail and checking for significant fuel flow at fuel rail outlets with Key On.

-No fuel exiting fuel rail outlets: Go to 5.

-Fuel exiting any injection outlets: Replace fuel rail

5. Check regulator joints and fittings for leaks using soap/water solution at Key On.
-Leaks/bubbles present: Tighten component(s) to specification or replace regulator if necessary. It may be possible to use a regulator rebuild kit if a trained technician understands the factor guidelines for regulator (reducer) rebuilding.

DTC 94: Fuel system leak detected – Small leak

This diagnostic looks for leaks between the regulator and the injector fuel rail. It can detect gross leaks in various connections / hoses and even minute seat leaks in the injectors as they age and wear.

Possible Causes
A. Damaged/leaking fuel/ loose line or fittings
B. Damaged/leaking fuel filter
C. Damaged/leaking fuel rail and injectors
D. Damaged/leaking regulator

1. Check fuel lines between regulator and fuel rail, including fuel filter, for gas leaks using a soap/water solution with Key On.
-No visible leaks or bubbles: Go to 2.
-Visible leaks/bubbles: Replace damaged fuel hose components, seals, or clean and tighten loose connections
2. Check fuel rail for external leaks using soap/water solution with Key On.
-No obvious leaks: Go to 3.
-Visible leaks/bubbles: Clean and tighten loose components, replace fuel rail if necessary
3. Check fuel rail for internal leaks by disconnecting fuel injection hoses (to the intake ports) from fuel rail and checking for trace fuel flow at fuel rail outlets with Key On.
-No fuel exiting fuel rail outlets: Go to 4.
-Fuel exiting any injection outlets: Replace fuel rail
4. Check regulator joints and fittings for leaks using soap/water solution at Key On.
-Leaks/bubbles present: Tighten component(s) to specification or replace regulator if necessary. It may be possible to use a regulator rebuild kit if a trained technician understands the factor guidelines for regulator (reducer) rebuilding

DTC 107: Manifold absolute pressure circuit low input

This diagnostic checks to see if the MAP sensor voltage is within the expected range. It issues a code if the apparent voltage is too low.

Possible Causes
A. Manifold pressure sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. MAP Sensor is defective
E. ECU defective

1. Is the MAP sensor connected?
-Yes: Go to 2.

-No: Reconnect and test again

2. Test for continuity between MAP connector Pins and Chassis Ground with Key off.
   -Only Pin 4 is continuous: Go to 3.
   -Pins 1, 2 or 3 are continuous: Locate and rectify short in harness
3. Test harness continuity.
   -Continuities are T-MAP Connector Pin 1 --- ECU C1
   T-MAP Connector Pin 2 --- ECU C3
   T-MAP Connector Pin 3 --- ECU C2
   T-MAP Connector Pin 4 --- ECU C4 : Go to 4.
   -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On and connector disconnected from the MAP sensor.
   -Connector T-MAP Connector Pin 1 is 5 +/- 0.5V
   T-MAP Connector Pin 2 is 5 +/- 0.5V
   T-MAP Connector Pin 3 is 5 +/- 0.5V
   T-MAP Connector Pin 4 is 0 +/- 0.5V: Go to 5.
   -Voltage outputs out of specification: Replace ECU to see if problem can be eliminated.
5. Test manifold pressure sensor output.
   -If the manifold pressure not equal to atmospheric* +/- 50 mbar pressure at Key On: Replace MAP sensor
   - *For reference, check barometric pressure sensor value with service tool.

DTC 108: Manifold absolute pressure circuit high input

This diagnostic checks to see if the MAP sensor voltage is within the expected range. It issues a code if the apparent voltage is too high.

Possible Causes

A. Manifold pressure sensor disconnected
B. Harness is shorted to power
C. Harness wires are broken / damaged
D. MAP Sensor is defective
E. ECU defective

1. Is the MAP sensor connected?
   -Yes: Go to 2.
   -No: Reconnect and test again
2. Test for battery voltage at TMAP connector Pins with Key off
   -No voltage at connector: Go to 3.
   -Voltage at connector: Locate and rectify short to power in harness
3. Test harness continuity.
   -Continuities are T-MAP Connector Pin 1 --- ECU C1
   T-MAP Connector Pin 2 --- ECU C3
   T-MAP Connector Pin 3 --- ECU C2
   T-MAP Connector Pin 4 --- ECU C4 : Go to 4.
   -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On and connector disconnected from the MAP sensor.
   -Connector T-MAP Connector Pin 1 is 5 +/- 0.5V

T-MAP Connector Pin 2 is 5 +/- 0.5V
T-MAP Connector Pin 3 is 5 +/- 0.5V
T-MAP Connector Pin 4 is 0 +/- 0.5V: Go to 5.

-Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none

5. Test manifold pressure sensor output.
   -If the manifold pressure not equal to atmospheric +/- 50 mbar pressure at Key On: Replace MAP sensor
   - *For reference, check barometric pressure sensor value with service tool.

DTC 112: Intake air temperature sensor 1 circuit low

This diagnostic senses an out of range error (low voltage) for the intake temperature sensor found in the T-MAP sensor mounted on the intake manifold.

Possible Causes
A. Manifold temperature/pressure sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Temperature circuit in T-MAP sensor is defective
E. ECU defective

1. Is the Manifold Temperature/pressure sensor connected?
   -Yes: Go to 2.
   -No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground with Key off.
   -Only Pin 4 is continuous: Go to 3.
   -Pins 1, 2 or 3 are continuous: Locate and rectify short in harness
3. Test harness continuity.
   -Continuities are T-MAP Connector Pin 1 --- ECU C1
   T-MAP Connector Pin 2 --- ECU C3
   T-MAP Connector Pin 3 --- ECU C2
   T-MAP Connector Pin 4 --- ECU C4 : Go to 4.
   -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On.
   -Connector T-MAP Connector Pin 1 is 5 +/- 0.5V
   T-MAP Connector Pin 2 is 5 +/- 0.5V
   T-MAP Connector Pin 3 is 5 +/- 0.5V
   T-MAP Connector Pin 4 is 0 +/- 0.5V: Go to 5.
   -Voltage outputs out of specification: Replace ECU
5. Test manifold intake temperature sensor output with Juniper service tool.
   -With a warm or cold engine, the reported intake temperature should typically be between that ambient air temperature and the coolant temperature at Key On. If possible, let the engine cool down and the intake temperature should approach ambient temperature as will the coolant temperature sensor. If there is a large discrepancy (more than +/- 5°C (9 °F) variance), then replace the T-MAP sensor as it may be out of calibration.

DTC 113: Intake air temperature sensor 1 circuit high

This diagnostic senses an out of range error (high voltage) for the intake temperature sensor found in the T-MAP sensor mounted on the intake manifold.

Possible Causes
A. Manifold temperature/pressure sensor disconnected
B. Harness is shorted to power
C. Harness wires are broken / damaged
D. Temperature circuit in T-MAP Sensor is defective
E. ECU defective

1. Is the Manifold Temperature/pressure sensor connected?
   -Yes: Go to 2.
   -No: Reconnect and test again
2. Test for battery voltage at connector Pins with Key off
   -No battery voltage at connector: Go to 3.
   -Battery voltage at connector: Locate and rectify short to power in harness
3. Test harness continuity.
   -Continuities are T-MAP Connector Pin 1 --- ECU C1
   T-MAP Connector Pin 2 --- ECU C3
   T-MAP Connector Pin 3 --- ECU C2
   T-MAP Connector Pin 4 --- ECU C4 : Go to 4.
   -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On.
   -Connector T-MAP Connector Pin 1 is 5 +/- 0.5V
   T-MAP Connector Pin 2 is 5 +/- 0.5V
   T-MAP Connector Pin 3 is 5 +/- 0.5V
   T-MAP Connector Pin 4 is 0 +/- 0.5V: Go to 5.
   -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
5. Test manifold intake temperature sensor output with Juniper service tool.
   - With a warm or cold engine, the reported intake temperature should typically be between that ambient air temperature or less than coolant temperature at Key On. If possible, let the engine cool down and the intake temperature should approach ambient temperature as will the coolant temperature sensor. If there is a large discrepancy (more than +/- 5°C (9 °F) variance), then replace the T-MAP sensor as it may be out of calibration.

DTC 117: Engine coolant temperature circuit low

This diagnostic senses an out of range error (low voltage) for the engine coolant temperature (ECT) sensor found.

Possible Causes
A. Coolant temperature sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Temperature Sensor is defective
E. ECU defective

1. Is the coolant temperature sensor connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground with Key off.
    -Only Pin 1 is continuous: Go to 3.
    -Pin 2 is continuous: Locate and rectify short in harness
3. Disconnect ECT connector and test harness continuity.
    -Continuities are ECT connector Pin 1 --- ECU L3
    ECT connector Pin 2 --- ECU D2: Go to 4.
    -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with sensor disconnected.
    -Connector ECT connector Pin 1 is 0 +/- 0.5V
    ECT connector Pin 2 is 5 +/- 0.5V: Go to 5.
    -Voltage values out of specification: Check for shorts to battery voltage, replace ECU if none
5. Test coolant temperature sensor output with Juniper service tool.
    -If reported coolant temperature is less that ambient or greater than 125 degrees C at Key On: Replace Coolant temperature sensor

DTC 118: Engine coolant temperature circuit high

This diagnostic senses an out of range error (high voltage) for the engine coolant temperature (ECT) sensor found.

Possible Causes
A. Coolant temperature sensor disconnected
B. Harness is shorted to power
C. Harness wires are broken / damaged
D. Temperature Sensor is defective
E. ECU defective

1. Is the coolant temperature sensor connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Test for voltage at connector with Key Off.
    -No voltage present: Go to 3.
    -Voltage present: Locate and rectify short to power in harness
3. Test harness continuity.
    -Continuities are ECT connector Pin 1 --- ECU L3
    ECT connector Pin 2 --- ECU D2: Go to 4.
    -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with sensor disconnected.
    -Connector ECT connector Pin 1 is 0 +/- 0.5V
    ECT connector Pin 2 is 5 +/- 0.5V: Go to 5.
    -Voltage values out of specification: Check for shorts to battery voltage, replace ECU if none
5. Test coolant temperature sensor output with Juniper service tool.
    -If reported coolant temperature is less that ambient or greater than 125 degrees C at Key On: Replace Coolant temperature sensor

DTC 122: Throttle position sensor "A" circuit low

Possible Causes
A. Electronic throttle body disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Electronic throttle body is defective
E. ECU defective

1. Is the electronic throttle body connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
    -Only Pin 6 is continuous: Go to 3.
    -Other Pins are continuous to ground: Locate and rectify short in harness
3. Test harness continuity.
    -Continuities are Throttle body connector Pin 1 --- ECU G3
    Throttle body connector Pin 2 --- ECU F3
    Throttle body connector Pin 3 --- ECU Q3
    Throttle body connector Pin 4 --- ECU G4
    Throttle body connector Pin 5 --- ECU Q4
    Throttle body connector Pin 6 --- ECU F4: Go to 4.
    -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On.
    -Connector Throttle body connector Pin 1 is 3.75 +/- 0.5V
    Throttle body connector Pin 2 is 5 +/- 0.5V
    Throttle body connector Pin 3 is 5 +/- 0.5V
    Throttle body connector Pin 4 is 3.75 +/- 0.5V
    Throttle body connector Pin 5 is 0 +/- 0.5V
    Throttle body connector Pin 6 is 0 +/- 0.5V: Go to 5.
    -If voltage outputs are out of specification: Check for shorts to battery voltage, replace ECU if none
5. Test TPS 1 output with Juniper service tool at Key On.
    -if TPS 1 output is not 1.5 +/- 0.5 V: Replace throttle body

DTC 123: Throttle position sensor "A" circuit high

Possible Causes
A. Electronic throttle body disconnected
B. Harness is shorted to power
C. Harness wires are broken / damaged
D. Electronic throttle body is defective
E. ECU defective

1. Is the electronic throttle body connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Test for voltage between connector Pins and Chassis Ground with Key Off for at least 25 seconds.

-No voltage present: Go to 3.
-voltage present: Locate and rectify short to power in harness

3. Test harness continuity.
-Continuities are Throttle body connector Pin 1 --- ECU G3
Throttle body connector Pin 2 --- ECU F3
Throttle body connector Pin 3 --- ECU Q3
Throttle body connector Pin 4 --- ECU G4
Throttle body connector Pin 5 --- ECU Q4
Throttle body connector Pin 6 --- ECU F4: Go to 4.
-Anything other than above: Locate and Rectify harness damage

4. Test ECU voltage outputs at Key On.
-Connector Throttle body connector Pin 1 is 3.75 +/- 0.5V
Throttle body connector Pin 2 is 5 +/- 0.5V
Throttle body connector Pin 3 is 5 +/- 0.5V
Throttle body connector Pin 4 is 3.75 +/- 0.5V
Throttle body connector Pin 5 is 0 +/- 0.5V
Throttle body connector Pin 6 is 0 +/- 0.5V: Go to 5.
-If voltage outputs are out of specification: Check for shorts to battery voltage, replace ECU if none

5. Test TPS 1 output with Juniper service tool at Key On.
-TPS 1 output not 1.5 V +/- 0.5 V: Replace throttle body

DTC 126: Insufficient coolant temperature for stable operation

Possible Causes
A. Extremely low ambient temperature, engine not warmed
B. Coolant temperature sensor disconnected
C. Coolant level low
D. Coolant thermostat defective
E. Harness is shorted to ground
F. Harness wires are broken / damaged
G. Temperature Sensor is defective
H. ECU defective

1. Let the engine idle for 5 minutes and test foot pedal response.
-No response: Go to 2.

2. Is the coolant temperature sensor connected?
-Yes: Go to 3.
-No: Reconnect and test again

3. Check coolant level.
-Fluid level nominal: Go to 4.
-Fluid level low: Fill according to coolant filling / air bleeding procedure and test again

4. Test for continuity between ECT connector Pins and Chassis Ground
-If Only Pin 1 is continuous: Go to 5.
-If Pin 2 is continuous: Locate and rectify short in harness

5. Test harness continuity.
-Continuities are ECT connector Pin 1 --- ECU L3
ECT connector Pin 2 --- ECU D2: Go to 6.
-If there is anything other than above: Locate and Rectify harness damage

6. Test ECU voltage outputs at Key On with sensor disconnected.
    -Connector ECT connector Pin 1 is 0 +/- 0.5V
    ECT connector Pin 2 is 5 +/- 0.5V: Go to 7.
    -If voltage outputs are out of specification: Check for shorts to battery voltage, replace ECU if there are none
7. Test coolant temperature sensor output with Juniper service tool.
    -If reported coolant temperature is between ambient temperature and 125 degrees C at Key On: Go to 8.
    -If reported coolant temperature is less that ambient or greater than 125 degrees C at Key On: Replace Coolant temperature sensor
8. Drain coolant and remove thermostat to test thermostat functionality in boiling water with thermometer as a reference (if possible).
    -If thermostat does not open fully by 92 degrees C (198 degrees F): Replace thermostat

DTC 127: Intake air temperature too high

This diagnostic detects excessively warm intake air temperature.

Possible Causes
A. Manifold temperature/pressure sensor disconnected
B. Engine is overheating
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. TMAP Sensor is defective
E. ECU defective

1. Is the Manifold Temperature/pressure sensor connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Check coolant level.
    -Fluid level nominal: Go to 3.
    -Fluid level low: Fill coolant according to procedure and retest
3. Test for continuity between connector Pins and Chassis Ground with Key off.
    -Only Pin 4 is continuous: Go to 4.
    -Pins 1, 2 or 3 are continuous: Locate and rectify short in harness
4. Test harness continuity.
    -Continuities are T-MAP Connector Pin 1 --- ECU C1
    T-MAP Connector Pin 2 --- ECU C3
    T-MAP Connector Pin 3 --- ECU C2
    T-MAP Connector Pin 4 --- ECU C4: Go to 5.
    -Anything other than above: Locate and Rectify harness damage
5. Test ECU voltage outputs at Key On with sensor disconnected
    -Connector T-MAP Connector Pin 1 is 5 +/- 0.5V
    T-MAP Connector Pin 2 is 5 +/- 0.5V
    T-MAP Connector Pin 3 is 5 +/- 0.5V
    T-MAP Connector Pin 4 is 0 +/- 0.5V: Go to 6.
    -Voltage outputs out of specification: Replace ECU
6. Check coolant temperature with Juniper service tool.

-if coolant is greater than ambient temperature and less that 120 degrees C: Go to 7.

-Coolant is greater than 120 degrees C: Drain coolant and test thermostat functionality

7. Test manifold intake temperature sensor output with Juniper service tool.

-Reported intake temperature is significantly less that ambient or greater than coolant temperature at Key On: Replace T-MAP sensor (as temperature sub-circuit may have failed.)

DTC 129: Barometric pressure too low

This diagnostic detects the barometric absolute pressure sensor (BAP) failure. Because the BAP is internal to the ECU (mounted directly on the motherboard) it cannot be accessed for replacement. An out of range value will automatically cause software to default to a fixed value and issue the DTC 129.

Possible Causes

A. Plugged ECU vent hole
B. Defective ECU circuitry or sensor

1. Check that the vent hole on the ECU (black button-sized plastic insert in center of die-cast cover) is not obstructed by oily deposits, sealant or paint that prevents air from moving in/out (note: this type of failure is highly unlikely. However, if the vent was in fact sealed, and air in ECU was trapped, significant BAP errors inside ECU would be driven by large altitude changes (at least 500 m or 1500 feet), significant weather changes and normal under hood temperature changes (cold starting / hot running/ hot re-start).
2. Check barometric pressure using Juniper service tool at key-on / 0 rpm.

-If the reported barometric pressure is more than +/-100 mBar of the actual atmospheric pressure and the MAP signal, then the code will be issued. Note that small errors (such as 50 mbar) do not significantly affect control system accuracy due to closed loop correction.

- If the vent is clear then replace the ECU

DTC 131: O2 sensor circuit low voltage bank 1 sensor 1,
DTC 132: O2 sensor circuit high voltage bank 1 sensor 1,
DTC 135: O2 Sensor Heater circuit bank 1 sensor 1

Possible Causes

A. Pre Catalyst oxygen sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged/shorted to power - Vref wire (i.e. 3.3 V or 5.0 V) or Vbat wire (12 V to 14 V).
D. Pre catalyst oxygen sensor or internal heater is defective
E. ECU defective

1. Is the pre catalyst oxygen sensor connected?

-Yes: Go to 2.

-No: Reconnect and test again

2. Test for continuity between connector Pins and Chassis Ground with Key Off.

-Only Pin 1 is continuous: Go to 3.
-Other Pins are continuous: Locate and rectify short in harness

3. Test harness continuity.
-Continuities are Lambda 1 connector Pin 1 --- ECU M4
Lambda 1 connector Pin 2 --- ECU L1
Lambda 1 connector Pin 3 --- ECU M2
Lambda 1 connector Pin 4 --- Engine Main Relay Receptacle B Pin 87
: Go to 4.
-Anything other than above: Locate and Rectify harness damage

4. Test ECU voltage outputs at Key On.
-Connector Lambda 1 connector Pin 1 is 0 +/- 0.5V
Lambda 1 connector Pin 2 is 2 +/- 1V
Lambda 1 connector Pin 3 is 0 +/- 0.5V
Lambda 1 connector Pin 4 is a complex duty cycle modulated battery voltage. It is best to check with a fast acting multimeter when sensor is cold. Look for a peak voltage near the battery voltage and also determine averaged voltage (which changes with time as sensor warms up). If there is activity go to 5.
-If voltage outputs are out of specification: Check for shorts to battery voltage or other reference voltages in harness, replace ECU if no harness faults found.

5. Test oxygen sensor 1 output with Juniper service tool at warm idle.
-If oxygen sensor does not cycle between low (less than 250 mV) and high (greater than 650 mV): Replace pre catalyst oxygen sensor.

DTC 137: O2 sensor circuit low voltage bank 1 sensor 2,
DTC 138: O2 sensor circuit high voltage bank 1 sensor 2,
DTC 141: O2 Sensor Heater circuit bank 1 sensor 2

Possible Causes
A. Post Catalyst oxygen sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Post catalyst oxygen sensor or internal heater is defective
E. ECU defective

1. Is the post catalyst oxygen sensor connected?
-Yes: Go to 2.
-No: Reconnect and test again

2. Test for continuity between connector Pins and Chassis Ground with Key Off.
-Only Pin 1 is continuous: Go to 3.
-Other Pins are continuous: Locate and rectify short in harness

3. Test harness continuity.
-Continuities are Lambda 2 connector Pin 1 --- ECU M4
Lambda 2 connector Pin 2 --- ECU L2
Lambda 2 connector Pin 3 --- ECU M1
Lambda 2 connector Pin 4 --- Engine Main Relay Receptacle B Pin 87
: Go to 4.
-Anything other than above: Locate and Rectify harness damage

4. Test ECU voltage outputs at Key On.
-Connector Lambda 2 connector Pin 1 is 0 +/- 0.5V
Lambda 2 connector Pin 2 is 2 +/- 1V
Lambda 2 connector Pin 3 is 0 +/- 0.5V
Lambda 2 connector Pin 4 is a complex duty cycle modulated battery voltage. It is best to check with a fast acting multimeter when sensor is cold. Look for a peak voltage near the battery voltage and also determine averaged voltage (which changes with time as sensor warms up). If there is activity go to 5.
- If voltage outputs are out of specification: Check for shorts to battery voltage or other reference voltages in harness, replace ECU if no harness faults found.
5. Test oxygen sensor 2 output with Juniper service tool at warm idle in closed loop mode with no other DTCs.
-Oxygen sensor should average between 200 mV and 700 mV: If not replace post catalyst oxygen sensor.

DTC 168: Fuel temperature too high

Possible Causes
A. Fuel rail temperature/pressure sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Fuel rail temperature/pressure sensor is defective
E. Engine operating above normal coolant temperature
F. ECU defective

1. Is the Fuel rail temperature/pressure sensor connected?
-Yes: Go to 2.
-No: Reconnect and test again
2. Test for continuity between TP Rail connector Pins and Chassis Ground with Key Off for at least 25 seconds.
-Only Pin 1 is continuous: Go to 3.
-Other Pins are continuous: Locate and rectify short in harness
3. Test harness continuity.
-Continuities are TP Fuel Rail Connector Pin 1 --- ECU C4
TP Fuel Rail Connector Pin 2 --- ECU E1
TP Fuel Rail Connector Pin 3 --- ECU D1
TP Fuel Rail Connector Pin 4 --- ECU C3: Go to 4.
-Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with TP fuel rail sensor disconnected:
-Connector TP Fuel Rail Connector Pin 1 is 0 +/- 0.5V
TP Fuel Rail Connector Pin 2 is 5 +/- 0.5V
TP Fuel Rail Connector Pin 3 is 5 +/- 0.5V
TP Fuel Rail Connector Pin 4 is 5 +/- 0.5V: Go to 5.
-Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
5. Is the engine coolant temperature greater than 105 degrees C as reported by Juniper service tool?
-No: Go to 6.
-Yes: Determine and rectify reason for engine coolant over temperature

6. Check fuel temperature as reported by Juniper service tool after allowing engine to cool to ambient temperature. Touch fuel rail to assess that it is near ambient temperature.

-Rail temperature differs from ambient by more than 20 degrees C: Fuel rail temperature/pressure sensor is defective, replace with new sensor.

DTC 171: System too lean
DTC 172: System too rich

Possible Causes

A. Fuel pressure out of specification
B. Pre Catalyst oxygen sensor disconnected
C. Exhaust leak
D. Harness is shorted to ground
E. Harness wires are broken / damaged
F. Pre Catalyst oxygen sensor is defective
G. Fuel rail/ injection hoses damaged/plugged
H. Base engine out of specification
I. ECU defective

1. Is the fuel level or pressure too low?
   -No: Go to 2.
   -Yes: Replace fuel tank
2. Is the pre catalyst oxygen sensor connected?
   -Yes: Go to 3.
   -No: Connect and retest
3. Is the Pre Catalyst O2 sensor loose or are there any exhaust leaks between cylinder head and tail pipe?
   -No: Go to 4.
   -Yes: Tighten O2 sensor with O2 sensor socket, replace any leaking exhaust gaskets and retest.
4. Is the absolute fuel rail pressure greater than 2000 mBar and less than 3000 mBar at Key on?
   -Yes: Go to 5.
   -No: Ensure fuel shutoff valve is operating, if problem persists, replace regulator or service shutoff valve itself (trained personnel only).
5. Is the absolute fuel rail pressure greater than 1200 mBar and less than 2200 mBar at idle?
   -Yes: Go to 6.
   -No: Ensure manifold vacuum reference is connected to regulator, then replace gaseous fuel filter if problem persists
6. Test for continuity between pre-catalyst O2 sensor connector Pins and Chassis Ground with Key Off.
   -Only Lambda 1 connector Pin 1 is continuous: Go to 7.
   -Other Pins are continuous: Locate and rectify short in harness
7. Test pre-catalyst O2 sensor harness continuity.
   -Continuities are Lambda 1 connector Pin 1 --- ECU M4
   Lambda 1 connector Pin 2 --- ECU L1
   Lambda 1 connector Pin 3 --- ECU M2

Lambda 1 connector Pin 4 --- Engine Main Relay
Receptacle B Pin 87
: Go to 8.

-Anything other than above: Locate and Rectify harness damage

8. Test ECU voltage outputs at Key On.

-Connector Lambda 1 connector Pin 1 is 0 +/- 0.5V
Lambda 1 connector Pin 2 is 2 +/- 1V
Lambda 1 connector Pin 3 is 0 +/- 0.5V
Lambda 1 connector Pin 4 is battery V : Go to 9.

-Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none

9. Compare oxygen sensors 1 and 2 outputs using Juniper service tool at warm idle.

-Both sensors are reading continuously rich (greater than 450 mV) or continuously lean (less than 450 mV) or are cycling through 450 mV: Go to 10.

-One sensor reads lean (less than 450 mV) while the other reads rich (greater than 450 mV): Replace pre catalyst oxygen sensor

10. Check for fuel injector leakages using active diagnostic procedure in Juniper service tool.

-Leakage is less than 10 mBar: Go to 11.

-Leakage is greater than 10 mBar: Inspect injectors and gaseous fuel lines for leaks, replace fuel injector rail.

11. Compare short term fuel trim using Juniper service tool at idle with another fuel rail.

-short term fuel trims differ by less than 0.25: Go to 12.

-Short term fuel trims differ by more than 0.25: Replace fuel rail

12. Inspect whether base engine is within specification, including cylinder compression, valve clearances, intake and exhaust leaks.

-Especially look for leakage through the intake valve as this can reduce volumetric efficiency.

- On older engines or those with poor oil maintenance assess the combustion blow (past piston rings) by at idle by pulling the PCV valve out of the valve cover (allowing fresh air to enter PCV valve and flow to intake manifold) and determine if the short term fuel trim changes by at least 15% indicating significantly increased airflow and better volumetric efficiency. If the blow-by is high at idle, piston rings and the cylinder walls may dictate an engine rebuild.

-Repair any issues found

DTC 182: Fuel temperature sensor “A” circuit low
DTC 183: Fuel temperature sensor “A” circuit high
DTC 192: Fuel rail pressure sensor circuit low
DTC 193: Fuel rail pressure sensor circuit high

Possible Causes

A. Fuel rail temperature/pressure sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Fuel rail temperature/pressure sensor is defective
E. ECU defective

1. Is the Fuel rail temperature/pressure sensor connected?

-Yes: Go to 2.

-No: Reconnect and test again

2. Test for continuity between TP Rail connector Pins and Chassis Ground with Key Off for at least 25 seconds.
   -Only Pin 1 is continuous: Go to 3.
   -Other Pins are continuous: Locate and rectify short in harness
3. Test harness continuity.
   -Continuities are TP Fuel Rail Connector Pin 1 --- ECU C4
   TP Fuel Rail Connector Pin 2 --- ECU E1
   TP Fuel Rail Connector Pin 3 --- ECU D1
   TP Fuel Rail Connector Pin 4 --- ECU C3: Go to 4.
   -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with sensor disconnected.
   -Connector TP Fuel Rail Connector Pin 1 is 0 +/- 0.5V
   TP Fuel Rail Connector Pin 2 is 5 +/- 0.5V
   TP Fuel Rail Connector Pin 3 is 5 +/- 0.5V
   TP Fuel Rail Connector Pin 4 is 5 +/- 0.5V : Go to 5.
   -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
5. Check temperature and pressure values with Juniper service tool at idle.
   The temperature of the fuel should between room temperature and coolant temperature.
   The absolute fuel rail pressure should be greater than 1200 mBar and less than 2500 mbar.
6. Check for similar DTC and operational values using another TP Fuel rail sensor or complete rail.
   -Cleared DTC does not return with new sensor/ fuel rail, but does when returning to original parts: Replace T-MAP sensor and verify codes when away.

DTC 217: Engine coolant over temperature condition

Possible Causes

A. Coolant level low
B. Low airflow: Radiator air flow blocked/restricted
C. Low water flow: water pump belt broken, slipping or air lock in coolant flow
D. Thermostat defective
E. Coolant temperature sensor disconnected
F. Harness is shorted to power
G. Harness wires are broken / damaged
H. Engine coolant temperature (ECT) sensor is defective
H. ECU defective

1. Is the coolant level full?
   -Yes: Go to 2.
   -No: Fill coolant and follow coolant bleed procedure
2. Is the vaporizer/regulator at coolant temperature?
   -Yes: Go to 3.
   -No: Perform coolant bleed procedure
3. Is the coolant temperature sensor connected?
   -Yes: Go to 4.
   -No: Reconnect and test again

4. Test for voltage at coolant sensor connector with Key Off.
    -No voltage present: Go to 5.
    -Voltage present: Locate and rectify short to power in harness
5. Test harness continuity.
    -Continuities are ECT sensor connector Pin 1 --- ECU L3
    ECT sensor connector Pin 2 --- ECU D2: Go to 6.
    -Anything other than above: Locate and Rectify harness damage
6. Test ECU voltage outputs at Key On.
    -Connector ECT sensor connector Pin 1 is 0 +/- 0.5V
    ECT sensor connector Pin 2 is 5 +/- 0.5V: Go to 7.
    -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
7. Test coolant temperature sensor output with Juniper service tool at Key On.
    -Reported coolant temperature is between ambient and 125 degrees C: Go to 8.
    -Reported coolant temperature is significantly less than ambient or greater than 125 degrees C at Key On: Replace Coolant temperature sensor
8. Drain coolant, remove thermostat and test operation in boiling water.
    -Thermostat does not open before boiling water: Replace thermostat, refill coolant, and perform coolant bleed procedure
9. Check for obvious mechanical faults in cooling system and repair:
    - air locks in coolant system
    - air restrictions or debris in radiator
    - water pump belt tension or belt failed

DTC 219: Engine over-speed

Possible Causes
A. Forklift was accelerated down a steep grade and engine braking/governing was insufficient to limit speed.
B. Intake manifold vacuum leak
C. Throttle body defective

1. Clear active DTC. Start the engine and depress foot pedal to full throttle in neutral.
    -DTC does not return: Likely a false positive due to driving on a steep grade
    -DTC returns: Go to 2.
2. Inspect intake manifold, fuel hoses, throttle body, PCV, and vaporizer map reference for source of a vacuum leak.
    -No obvious vacuum leaks: Go to 3.
    -Vacuum leak found: correct and clear DTC
3. Remove air intake hose and inspect throttle valve at Key on.
    -Throttle is approximately 20 % open: Go to 4.
    -Throttle is not 20% open: Replace electronic throttle body
4. Inspect throttle valve after keying off (with Key On for 20 seconds minimum)
    -Throttle valve does not sweep fully open and closed (programmed for once every 10 key-on cycles): Replace electronic throttle body

DTC 222: Throttle position sensor "B" circuit low
DTC 223: Throttle position sensor "B" circuit high

Possible Causes
A. Electronic throttle body disconnected
B. Harness is shorted to ground or power
C. Harness wires are broken / damaged
D. Electronic throttle body is defective
E. ECU defective

1. Is the electronic throttle body connected?
   -Yes: Go to 2.
   -No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
   -Only Pin 6 is continuous: Go to 3.
   -Other Pins are continuous: Locate and rectify short in harness
3. Test harness continuity.
   -Continuities are Electronic throttle body connector Pin 1 --- ECU G3
   Electronic throttle body connector Pin 2 --- ECU F3
   Electronic throttle body connector Pin 3 --- ECU Q3
   Electronic throttle body connector Pin 4 --- ECU G4
   Electronic throttle body connector Pin 5 --- ECU Q4
   Electronic throttle body connector Pin 6 --- ECU F4
   : Go to 4.
   -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with sensor disconnected.
   -Connector Electronic throttle body connector Pin 1 is 3.75 +/- 0.5V
   Electronic throttle body connector Pin 2 is 5 +/- 0.5V
   Electronic throttle body connector Pin 3 is 5 +/- 0.5V
   Electronic throttle body connector Pin 4 is 3.75 +/- 0.5V
   Electronic throttle body connector Pin 5 is 0 +/- 0.5V
   Electronic throttle body connector Pin 6 is 0 +/- 0.5V: Go to 5.
   -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
5. Test TPS 2 output with Juniper service tool at Key On.
   -TPS 2 output not 3.6 +/- 0.5 V: Replace throttle body

DTC 261: Cylinder 1 injector circuit low
DTC 262: Cylinder 1 injector circuit high
DTC 263: Cylinder 2 injector circuit low
DTC 264: Cylinder 2 injector circuit high
DTC 265: Cylinder 3 injector circuit low
DTC 266: Cylinder 3 injector circuit high
DTC 267: Cylinder 4 injector circuit low
DTC 268: Cylinder 4 injector circuit high

Possible Causes
A. Fuel injector is disconnected
B. Harness is shorted to ground or power

C. Harness wires are broken / damaged
D. Injector solenoid is defective
E. ECU defective

1. Are all injectors connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground with Key On.
    -No pins are continuous with ground: Go to 3.
    -A Pin is continuous: Locate and rectify short to ground in harness
3. Test for battery voltage between connector Pins and Chassis Ground with Key Off.
    -No pins are powered: Go to 4.
    -Voltage present: Locate and rectify short to power in harness
4. Test for battery voltage between connector Pins and Chassis Ground with Key On.
    -Only Pin 1 is powered: Go to 5.
    -Voltage present on Pin 2: Locate and rectify short to power in harness
5. Test harness continuity.
    -Continuities are (for connectors Inj Gas1, Inj Gas2, Inj Gas3, Inj Gas4)
        Pin 1 --- Engine Main Relay
            Receptacle B Pin 87
        Pin 2 --- ECU Q1, P1, P2, Q2 respectively: Go to 6.
    -Anything other than above: Locate and Rectify harness damage
6. Test ECU voltage outputs at Key On (for connectors Inj Gas1, Inj Gas2, Inj Gas3, Inj Gas4) with injector disconnected
    -Connector Pin 1 is battery voltage +/- 0.5V
        Pin 2 is 1 +/- 1V: Go to 7.
    -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
7. Carefully test resistance of injector solenoids across 2 pins with a quality multimeter:
    -Resistance should typically be 3.1+/- 0.5 Ohms: Other wise replace solenoid

DTC 336: Crankshaft position sensor "A" circuit range / performance

Possible Causes
A. Crankshaft position sensor (CKPS) is disconnected
B. Harness is shorted to ground or power
C. Harness wires are broken / damaged
D. CKPS is not mounted flush with housing
E. CKPS is defective
F. ECU defective

1. Is the CKPS connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Is the CKPS mounted flush with the bell housing?
    -Yes: Go to 3.
    -No: Remount sensor flush, removing o-ring if necessary
    -Also verify CKPS clearance to flywheel markings. This should be to Hyundai specifications.
3. Test for continuity between connector Pins and Chassis Ground with Key On.

-Only Crank sensor connector Pin 2 is continuous with ground: Go to 4.
-Pin 1 or 3 is continuous to ground: Locate and rectify short to ground in harness
4. Test for battery voltage between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
-No pins are powered: Go to 5.
-Voltage present: Locate and rectify short to power in harness
5. Test harness continuity.
-Continuities are
CKPS connector Pin 1 --- ECU P4 and Main Relay Receptacle A Pin 87
CKPS connector Pin 2 --- ECU L4
CKPS connector Pin 3 --- ECU J2: Go to 6.
-Anything other than above: Locate and Rectify harness damage
6. Test ECU voltage outputs at Key On with sensor disconnected.
-Connector CKPS connector Pin 1 is battery voltage
CKPS connector Pin 2 is 0 +/- 0.5V
CKPS connector Pin 3 is 6.5 +/- 0.5V: Go to 7.
-Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
7. Replace CKPS with a new sensor and retest
-If the problem returns only after switching back to original CKPS, replace sensor

DTC 341: Camshaft position sensor "A" circuit range / performance

Possible Causes
A. Camshaft position sensor (CMPS) is disconnected
B. Harness is shorted to ground or power
C. Harness wires are broken / damaged
D. CMPS is not mounted flush with cylinder head
E. CMPS is defective
F. ECU defective

1. Is the CMPS connected?
-Yes: Go to 2.
-No: Reconnect and test again
2. Is the CMPS mounted flush with the cylinder head?
-Yes: Go to 3.
-No: Remount sensor flush,
-Also verify CMPS clearance to camshaft lobe. This should be to Hyundai specifications.
3. Test for continuity between connector Pins and Chassis Ground with Key On.
-Only Pin 2 is continuous with ground: Go to 4.
-Pin 1 or 3 is continuous: Locate and rectify short to ground in harness
4. Test for battery voltage between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
-No pins are powered: Go to 5.
-Voltage present: Locate and rectify short to power in harness
5. Test harness continuity.
-Continuities are
CMPS Pin 1 --- ECU P4 and Main Relay Receptacle A

Pin 87
CMPS Pin 2 --- ECU N4
CMPS Pin 3 --- ECU H1: Go to 6.

-Anything other than above: Locate and Rectify harness damage

6. Test ECU voltage outputs at Key On with sensor disconnected.

-Connector CMPS Pin 1 is battery voltage
CMPS Pin 2 is 0 +/- 0.5V
CMPS Pin 3 is 6.5 +/- 0.5V: Go to 7.

-Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none

7. Replace CMPS with a new sensor and retest

-If the problem returns only after switching back to original CMPS, replace sensor

DTC 380: Glow plug / heater circuit "A"

The glow plug circuit is designed to drive a relay but is not used in this application. No codes associated with the glow plug circuit should appear.

DTC 420: Catalyst system efficiency below threshold

This diagnostic feature detects catalyst function. If the catalyst is damaged or severely aged, this code could be observed.

Possible Causes

A. Exhaust leak causing significant control errors

B. Catalysts can be damaged by

- Misfire
- Severe mechanical loading / shaking – causing cracking/leak through
- Oil additive contamination / masking of catalytic surface
- Excess sulfur in fuel – also causing deactivation/masking
- Natural aging (sintering) in very old catalysts

1. Search entire exhaust system for exhaust leaks, or sources of fresh air getting into exhaust stream.

-No obvious leaks: Go to 2.

-Exhaust leak present: Repair exhaust

2. Check pre and post catalyst oxygen sensor voltages using Juniper service tool during warm idle.

-Oxygen sensor 2 voltage ranges high to low nearly as often as oxygen sensor 1 This indicates that the oxygen storage capacity is diminished.

- First drive the engine at high load if possible for 10 minutes to warm catalyst up and remove sulfur

- Also check the engine mechanical health (compression, leak-down tests and blow-by tests).

- If the code reappears within a few working days then replace the catalytic converter

DTC 524: Engine oil pressure too low

Possible Causes
A. Oil level low
B. Oil pressure switch disconnected
C. Short or damaged harness
D. Oil pressure switch defective
E. ECU defective
F. Base engine out of specification

1. Check the oil level.
    -Oil level full: Go to 2.
    -Oil level low: Fill oil using factory specified weight and grade
2. Is the oil pressure switch connected?
    -Yes: go to 3.
    -No: Connect and test again
3. Test for continuity between oil pressure switch connector Pin and Chassis Ground with Key off for at least 25 seconds.
    -Pin is not continuous with ground: Go to 4.
    -Pin is continuous: Locate and rectify short to ground in harness
4. Test harness continuity.
    -Continuities are Oil Pressure Switch Pin 1 --- ECU E2: Go to 5.
    -Anything other than above: Locate and Rectify harness damage
5. Test ECU voltage output at Key On.
    -Connector Pin 1 is 12 +/- 2V: Go to 6.
    -Voltage outputs out of specification: Replace ECU
6. Replace oil pressure switch and retest
    -Low pressure warning persists: Go to 7.
7. Troubleshoot base engine for low oil pressure according to Engine service manual
    – This is a serious mechanical fault that can lead to rapid engine failure.

DTC 562: System voltage low

Possible Causes
A. Main ECU fuse is broken
A. Charging fuse is broken
B. Alternator belt is slipping/damaged/missing
C. Alternator connection is loose / disconnected
D. Forklift battery is damaged/defective
E. Alternator is defective

1. Measure battery voltage with engine idling, jump start engine if it will not crank.
    -Voltage is less than 13 V: Go to 2.
    -Voltage is greater than 13V: Charge battery and retest, replace or service battery if DTC returns
2. Check ECU and alternator charging fuses for continuity.
    -Fuses are continuous: Go to 3.
    -Fuses are broken: Replace fuse
3. Check that alternator belt is tight/functioning
    -Belt is tight with no signs of wear: Go to 4.

-Belt is loose / damaged / missing: Tighten or replace belt as necessary

4. Inspect alternator charge, ground, and ignition connections
   -All connections are tight and free of corrosion: Go to 5.
   -Connections are loose or corroded: Clean and retighten connections
5. Check continuity between alternator output and forklift battery positive terminal (Clean any deposits)
   -Continuous: Go to 6.
   -No continuity: Locate short or break in charging harness between alternator and battery positive terminal
6. Measure alternator signal wire voltage at Key On.
   -Voltage is not battery voltage: Locate short or damage in alternator harness
   -Voltage is battery voltage: Replace alternator

DTC 563: System voltage high

Possible Causes

A. Voltage regulator in alternator is damaged / defective

1. Measure battery voltage with Key Off.
   -Voltage is less than 13.5 V: Go to 2.
   -Voltage is greater than 13.5 V: Allow battery to rest to return to less than 13.5 V
2. Measure battery voltage with engine running at full throttle.
   -Voltage is greater than 14.5 V: Replace or service alternator

DTC 642: Sensor reference voltage "A" circuit low
DTC 643: Sensor reference voltage "A" circuit high
DTC 652: Sensor reference voltage "B" circuit low
DTC 653: Sensor reference voltage "B" circuit high
DTC 698: Sensor reference voltage "C" circuit low
DTC 699: Sensor reference voltage "C" circuit high

Possible Causes

A. Engine sensors are disconnected / damaged
B. Shorted or damaged engine harness
C. ECU defective

1. Are the throttle body, rail pressure/temperature, foot pedal, and TMAP sensors connected?
   -Yes: Go to 2.
   -No: Connect and retest
2. Test Harness continuity at connectors with them disconnected from sensors.
   -Continuities are

Throttle Body Pin 1 --- ECU G3	TP Fuel Rail Pin 1 --- ECU C4
Throttle Body Pin 2 --- ECU F3	TP Fuel Rail Pin 2 --- ECU E1
Throttle Body Pin 3 --- ECU Q3	TP Fuel Rail Pin 3 --- ECU D1
Throttle Body Pin 4 --- ECU G4	TP Fuel Rail Pin 4 --- ECU C3
Throttle Body Pin 5 --- ECU Q4	
Throttle Body Pin 6 --- ECU F4	

Foot Pedal Pin 1 --- ECU J3 T-MAP Pin 1 --- ECU C1

Foot Pedal Pin 2 --- ECU H3 T-MAP Pin 2 --- ECU C3
Foot Pedal Pin 3 --- ECU J4 T-MAP Pin 3 --- ECU C2
Foot Pedal Pin 4 --- ECU J3 T-MAP Pin 4 --- ECU C4
Foot Pedal Pin 5 --- ECU H4
Foot Pedal Pin 6 --- ECU J4: Go to 3.

-Continuities are other than above: Locate break/short in harness and rectify

3. Test the sensor connector pins for continuity with ground with Key Off for at least 25 seconds.

-The only grounded Pins are:

Throttle Body Pin 6 TPRail Pin 1

Foot Pedal Pin 3 TMAP Pin 4
Foot Pedal Pin 6

: Go to 4.

-Other Pins are grounded: locate short to ground and rectify

4. Measure sensor connector pin voltages with Key On with sensor disconnected.

-Voltages are:

Throttle Body Pin 1 is 3.75 +/- 0.5V TP Fuel Rail Pin 1 --- 0 +/- 0.5V
Throttle Body Pin 2 is 5 +/- 0.5V TP Fuel Rail Pin 2 --- 5 +/- 0.5V
Throttle Body Pin 3 is 5 +/- 0.5V TP Fuel Rail Pin 3 --- 5 +/- 0.5V
Throttle Body Pin 4 is 3.75 +/- 0.5V TP Fuel Rail Pin 4 --- 5 +/- 0.5V
Throttle Body Pin 5 is 0 +/- 0.5V
Throttle Body Pin 6 is 0 +/- 0.5V

Foot Pedal Pin 1 --- 5 +/- 0.5V T-MAP Pin 1 --- 5 +/- 0.5V
Foot Pedal Pin 2 --- 5 +/- 0.5V T-MAP Pin 2 --- 5 +/- 0.5V
Foot Pedal Pin 3 --- 0 +/- 0.5V T-MAP Pin 3 --- 5 +/- 0.5V
Foot Pedal Pin 4 --- 5 +/- 0.5V T-MAP Pin 4 --- 0 +/- 0.5V
Foot Pedal Pin 5 --- 5 +/- 0.5V
Foot Pedal Pin 6 --- 0 +/- 0.5V : Go to 5.

-If voltages are other than above, look for shorts to power, replace ECU if none

5. Systematically replace sensors which are powered by the offending reference channel

-Retain the sensor change which results in the DTC not reappearing

DTC 1001: Fuel shut-off valve “B” control circuit / open
DTC 1002: Fuel shut-off valve “C” control circuit / open

These extra valves and associated DTCs are not in use on Clark forklifts

DTC 1101: Manifold absolute pressure too high
DTC 1102: Manifold absolute pressure too low

This diagnostic detects MAP signals that are out of normal range and may indicate electronic or mechanical faults.

Possible Causes
A. Manifold pressure sensor disconnected
B. Intake air filter clogged/dirty
C. Intake air plumbing is obstructed / restricted
D. Harness is shorted to ground
E. Harness wires are broken / damaged
F. MAP Sensor is defective
G. ECU defective

1. Is the MAP sensor connected?
   -Yes: Go to 2.
   -No: Reconnect and test again
2. Is the air intake filter clean and free flowing?
   -Yes: Go to 3.
   -No: Replace filter and retest
3. Is the air intake plumbing clear of obstruction and free flowing?
   -Yes: Go to 4.
   -No: Remove any obstruction and retest
4. Test for continuity between connector Pins and Chassis Ground
   -Only Pin 4 is continuous to ground: Go to 5.
   -Pins 1, 2 or 3 are continuous: Locate and rectify short in harness
5. Test harness continuity.
   -Continuities are T-MAP Connector Pin 1 --- ECU C1
   T-MAP Connector Pin 2 --- ECU C3
   T-MAP Connector Pin 3 --- ECU C2
   T-MAP Connector Pin 4 --- ECU C4 : Go to 6.
   -Anything other than above: Locate and Rectify harness damage
6. Test ECU voltage outputs at Key On with sensor disconnected.
   -Connector Pin 1 is 5 +/- 0.5V
   Pin 2 is 5 +/- 0.5V
   Pin 3 is 5 +/- 0.5V
   Pin 4 is 0 +/- 0.5V: Go to7.
   -Voltage outputs out of specification: Replace ECU
7. Test manifold pressure sensor output at Key On.
   -Manifold pressure not within 50 mBar of atmospheric pressure: Replace MAP sensor

DTC 1103: Barometric pressure too high

Possible Causes
A. Plugged ECU vent hole
B. Defective ECU circuitry or sensor

1. Check that the vent hole on the ECU (black button-sized plastic insert in center of die-cast cover) is not obstructed by oily deposits, sealant or paint that prevents air from moving in/out (note: this type of failure is highly unlikely. However, if the vent was in fact sealed, and air in ECU was trapped, significant BAP errors inside ECU would be driven by large altitude changes (at least 500 m or 1500 feet), significant weather changes and normal under hood temperature changes (cold starting / hot running/ hot re-start).
2. Check barometric pressure using Juniper service tool at key-on / 0 rpm.
    -If the reported barometric pressure is more than +/-100 mBar of that actual atmospheric pressure and the MAP signal, then the code will be issued. Note that small errors (such as 50 mbar) do not significantly affect control system accuracy due to closed loop correction.
    - If the vent is clear then replace the ECU

DTC 1104: Intake air temperature too low

This diagnostic senses excessively low intake air temperature sensor with the T-MAP sensor mounted on the intake manifold.

Possible Causes
A. Manifold temperature sensor disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. TMAP Sensor is defective
E. ECU defective

1. Is the TMAP sensor connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground
    -Only Pin 4 is continuous: Go to 3.
    -Pins 1, 2 or 3 are continuous: Locate and rectify short in harness
3. Test harness continuity.
    -Continuities are T-MAP Connector Pin 1 --- ECU C1
    T-MAP Connector Pin 2 --- ECU C3
    T-MAP Connector Pin 3 --- ECU C2
    T-MAP Connector Pin 4 --- ECU C4: Go to 4.
    -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with sensor disconnected.
    -Connector T-MAP Connector Pin 1 is 5 +/- 0.5V
    T-MAP Connector Pin 2 is 5 +/- 0.5V
    T-MAP Connector Pin 3 is 5 +/- 0.5V
    T-MAP Connector Pin 4 is 0 +/- 0.5V: Go to 5.
    -Voltage outputs out of specification: Replace ECU
5. Test manifold temperature sensor output at Key On.
    -With a warm or cold engine, the reported intake temperature should typically be between that ambient air temperature or less than coolant temperature at Key On. If possible, let the engine cool down and the intake temperature should approach ambient temperature as does the coolant temperature sensor. If there is a large discrepancy (more than +/- 5°C (9 °F) variance), then replace the T-MAP sensor as it may be out of calibration: Replace TMAP sensor

DTC 1105: Fuel temperature too low

Possible Causes
A. Fuel rail temperature/pressure sensor disconnected
B. Vaporizer/Regulator is freezing
C. Harness is shorted to ground
D. Harness wires are broken / damaged
E. Fuel rail temperature/pressure sensor is defective
F. ECU defective

1. Is the vaporizer/regulator operating at engine coolant temperature?
    -Yes: Go to 2.
    -No: Perform the engine coolant air bleed procedure
2. Is the Fuel rail temperature/pressure sensor connected?
    -Yes: Go to 3.
    -No: Reconnect and test again
3. Test for continuity between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
    -Only TP rail sensor Pin 1 is continuous: Go to 4.
    -Other Pins are continuous: Locate and rectify short in harness
4. Test harness continuity.
    -Continuities are TP rail sensor Pin 1 --- ECU C4
    TP rail sensor Pin 2 --- ECU E1
    TP rail sensor Pin 3 --- ECU D1
    TP rail sensor Pin 4 --- ECU C3: Go to 5.
    -Anything other than above: Locate and Rectify harness damage
5. Test ECU voltage outputs at Key On.
    -Connector TP rail sensor Pin 1 is 0 +/- 0.5V
    TP rail sensor Pin 2 is 5 +/- 0.5V
    TP rail sensor Pin 3 is 5 +/- 0.5V
    TP rail sensor Pin 4 is 5 +/- 0.5V: Go to 6.
    -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
6. Check for similar DTC using another sensor
    -Cleared DTC does not return with new sensor, but does when returning to original: Replace sensor

DTC 2100: Throttle actuator control motor open
DTC 2102: Throttle actuator control motor circuit low
DTC 2103: Throttle actuator control motor circuit high

Possible Causes
A. Electronic throttle body disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Electronic throttle body sensor is defective
E. ECU defective

1. Is the Electronic throttle body connected?
    -Yes: Go to 2.

-No: Reconnect and test again

2. Test for continuity between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
   -Only Pin 6 is continuous: Go to 3.
   -Other Pins are continuous: Locate and rectify short in harness
3. Test harness continuity.
   -Continuities are
   Electronic throttle body connector Pin 1 --- ECU G3
   Electronic throttle body connector Pin 2 --- ECU F3
   Electronic throttle body connector Pin 3 --- ECU Q3
   Electronic throttle body connector Pin 4 --- ECU G4
   Electronic throttle body connector Pin 5 --- ECU Q4
   Electronic throttle body connector Pin 6 --- ECU F4: Go to 4.
   -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with sensor disconnected.
   -Connector Electronic throttle body connector Pin 1 is 3.75 +/- 0.5V
   Electronic throttle body connector Pin 2 is 5 +/- 0.5V
   Electronic throttle body connector Pin 3 is 5 +/- 0.5V
   Electronic throttle body connector Pin 4 is 3.75 +/- 0.5V
   Electronic throttle body connector Pin 5 is 0 +/- 0.5V
   Electronic throttle body connector Pin 6 is 0 +/- 0.5V: Go to 5.
   -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
5. Connect a new throttle body and test for DTCs.
   -Cleared DTC does not return with new throttle, but does when returning to original: Replace electronic throttle body

DTC 2109: Throttle position sensor "A" minimum stop performance
DTC 2113: Throttle position sensor "B" minimum stop performance

Possible Causes
A. Electronic throttle body is physically obstructed
B. Electronic throttle body output has varied due to excessive wear
C. Harness is shorted to ground
D. Harness wires are broken / damaged
E. Electronic throttle body sensor is defective
F. ECU defective

1. Conduct a "Learn TPS min max stop positions" diagnostic using Juniper service tool, and clear DTCs.
   -DTC persists: Go to 2.
2. Remove air inlet hose and inspect throttle actuation
   -Throttle valve is clear of obstruction, and fully opens/closes when the "learn TPS min max positions" diagnostic is performed: Go to 3.
   -Throttle valve operation is restricted: Remove restriction
3. Test for continuity between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
   -Only Pin 6 is continuous: Go to 4.
   -Other Pins are continuous: Locate and rectify short in harness
4. Test harness continuity.

-Continuities are
Electronic throttle body connector Pin 1 --- ECU G3
Electronic throttle body connector Pin 2 --- ECU F3
Electronic throttle body connector Pin 3 --- ECU Q3
Electronic throttle body connector Pin 4 --- ECU G4
Electronic throttle body connector Pin 5 --- ECU Q4
Electronic throttle body connector Pin 6 --- ECU F4: Go to 5.
-Anything other than above: Locate and Rectify harness damage

5. Test ECU voltage outputs at throttle connector with Key On with sensor disconnected.
-Connector Electronic throttle body connector Pin 1 is 3.75 +/- 0.5V
Electronic throttle body connector Pin 2 is 5 +/- 0.5V
Electronic throttle body connector Pin 3 is 5 +/- 0.5V
Electronic throttle body connector Pin 4 is 3.75 +/- 0.5V
Electronic throttle body connector Pin 5 is 0 +/- 0.5V
Electronic throttle body connector Pin 6 is 0 +/- 0.5V: Go to 6.
-Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
6. Connect a new throttle body and test for DTCs.
-Cleared DTC does not return with new throttle, but does when returning to original: Replace electronic throttle body

DTC 2122: Pedal position sensor "D" circuit low input
DTC 2123: Pedal position sensor "D" circuit high input
DTC 2127: Pedal position sensor "E" circuit low input
DTC 2128: Pedal position sensor "E" circuit high input

Possible Causes
A. Foot pedal position sensor (FPP) disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Foot pedal position sensor is defective
E. ECU defective

1. Is the FPP connected?
-Yes: Go to 2.
-No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground with Key Off.
-Only Pins 3 and 6 are continuous: Go to 3.
-Other Pins are continuous: Locate and rectify short in harness
3. Test harness continuity.
-Continuities are
Foot Pedal position sensor connector Pin A --- ECU J3
Foot Pedal position sensor connector Pin B --- ECU H3
Foot Pedal position sensor connector Pin C --- ECU J4
Foot Pedal position sensor connector Pin D --- ECU J3
Foot Pedal position sensor connector Pin E --- ECU H4
Foot Pedal position sensor connector Pin F --- ECU J4: Go to 4.
-Anything other than above: Locate and Rectify harness damage

4. Test ECU voltage outputs at Key On with sensor disconnected.
    -Connector Foot Pedal position sensor connector Pin A is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin B is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin C is 0 +/- 0.5V
    Foot Pedal position sensor connector Pin D is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin E is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin F is 0 +/- 0.5V: Go to 5.
    -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
5. Check FPP voltage outputs using Juniper service tool with 0% throttle command.
    -FPP1 is greater than 4950 mV or FPP2 is less than 50 mV: Replace FPP
6. Check FPP voltage outputs using Juniper service tool with 100% throttle command.
    -FPP1 is less than 50 mV or FPP2 is greater than 4950 mV: Replace FPP

DTC 2135: Throttle pedal position sensors "A" / "B" voltage correlation

Possible Causes
A. Electronic throttle body disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Electronic throttle body sensor is defective
E. ECU defective

1. Is the Electronic throttle body connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Conduct a "Learn TPS min max stop positions" diagnostic using Juniper service tool, and clear DTCs.
    -DTC persists: Go to 3.
3. Test for continuity between connector Pins and Chassis Ground with Key Off.
    -Only Pin 6 is continuous: Go to 4.
    -Other Pins are continuous: Locate and rectify short in harness
4. Test harness continuity.
    -Continuities are
    Electronic throttle body connector Pin 1 --- ECU G3
    Electronic throttle body connector Pin 2 --- ECU F3
    Electronic throttle body connector Pin 3 --- ECU Q3
    Electronic throttle body connector Pin 4 --- ECU G4
    Electronic throttle body connector Pin 5 --- ECU Q4
    Electronic throttle body connector Pin 6 --- ECU F4: Go to 5.
    -Anything other than above: Locate and Rectify harness damage
5. Test ECU voltage outputs at Key On with sensor disconnected.
    -Connector Electronic throttle body connector Pin 1 is 3.75 +/- 0.5V
    Electronic throttle body connector Pin 2 is 5 +/- 0.5V
    Electronic throttle body connector Pin 3 is 5 +/- 0.5V
    Electronic throttle body connector Pin 4 is 3.75 +/- 0.5V
    Electronic throttle body connector Pin 5 is 0 +/- 0.5V
    Electronic throttle body connector Pin 6 is 0 +/- 0.5V: Go to 6.
    -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none

6. Connect a new throttle body and test for DTCs.
    -Cleared DTC does not return with new throttle, but does when returning to original: Replace electronic throttle body

DTC 2138: Pedal position sensor "D" / "E" voltage correlation

Possible Causes
A. Foot pedal position sensor (FPP) disconnected
B. Harness is shorted to ground
C. Harness wires are broken / damaged
D. Foot pedal position sensor is defective
E. ECU defective

1. Is the FPP connected?
    -Yes: Go to 2.
    -No: Reconnect and test again
2. Test for continuity between connector Pins and Chassis Ground with Key Off.
    -Only Pins 3 and 6 are continuous: Go to 3.
    -Other Pins are continuous: Locate and rectify short in harness
3. Test harness continuity.
    -Continuities are
    Foot Pedal position sensor connector Pin A --- ECU J3
    Foot Pedal position sensor connector Pin B --- ECU H3
    Foot Pedal position sensor connector Pin C --- ECU J4
    Foot Pedal position sensor connector Pin D --- ECU J3
    Foot Pedal position sensor connector Pin E --- ECU H4
    Foot Pedal position sensor connector Pin F --- ECU J4: Go to 4
    -Anything other than above: Locate and Rectify harness damage
4. Test ECU voltage outputs at Key On with sensor disconnected.
    -Connector Foot Pedal position sensor connector Pin A is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin B is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin C is 0 +/- 0.5V
    Foot Pedal position sensor connector Pin D is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin E is 5 +/- 0.5V
    Foot Pedal position sensor connector Pin F is 0 +/- 0.5V: Go to 5.
    -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
5. Check FPP voltage outputs using Juniper service tool with 0% throttle command.
    -FPP1 is greater than 4950 mV or FPP2 is less than 50 mV: Replace FPP
6. Check FPP voltage outputs using Juniper service tool with 100% throttle command.
    -FPP1 is less than 50 mV or FPP2 is greater than 4950 mV: Replace FPP

DTC 2163: Throttle position sensor "A" maximum stop performance
DTC 2164: Throttle position sensor "B" maximum stop performance

Possible Causes
A. Electronic throttle body output has varied due to excessive wear
B. Electronic throttle body is physically obstructed
C. Harness is shorted to ground

D. Harness wires are broken / damaged
E. Electronic throttle body sensor is defective
F. ECU defective

1. Conduct a “Learn TPS min max stop positions” diagnostic using Juniper service tool, and clear DTCs.
-DTC persists: Go to 2.
2. Remove air inlet hose and inspect throttle actuation
-Throttle valve is clear of obstruction, and fully opens/closes when the “learn TPS min max positions” diagnostic is performed: Go to 3.
-Throttle valve operation is restricted: Remove restriction
3. Test for continuity between connector Pins and Chassis Ground with Key Off for at least 25 seconds.
-Only Pin 6 is continuous: Go to 4.
-Other Pins are continuous: Locate and rectify short in harness
4. Test harness continuity.
-Continuities are
Electronic throttle body connector Pin 1 --- ECU G3
Electronic throttle body connector Pin 2 --- ECU F3
Electronic throttle body connector Pin 3 --- ECU Q3
Electronic throttle body connector Pin 4 --- ECU G4
Electronic throttle body connector Pin 5 --- ECU Q4
Electronic throttle body connector Pin 6 --- ECU F4: Go to 5.
-Anything other than above: Locate and Rectify harness damage
5. Test ECU voltage outputs at throttle connector with Key On with sensor disconnected.
.
-Connector Electronic throttle body connector Pin 1 is 3.75 +/- 0.5V
Electronic throttle body connector Pin 2 is 5 +/- 0.5V
Electronic throttle body connector Pin 3 is 5 +/- 0.5V
Electronic throttle body connector Pin 4 is 3.75 +/- 0.5V
Electronic throttle body connector Pin 5 is 0 +/- 0.5V
Electronic throttle body connector Pin 6 is 0 +/- 0.5V: Go to 6.

-Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
6. Connect a new throttle body and test for DTCs.
-Cleared DTC does not return with new throttle, but does when returning to original: Replace electronic throttle body

DTC 2195: O2 sensor signal stuck lean bank 1 sensor 1
DTC 2196: O2 sensor signal stuck rich bank 1 sensor 1

Possible Causes

A. Fuel pressure out of specification
B. Pre Catalyst oxygen sensor disconnected
C. Harness is shorted to ground
D. Harness wires are broken / damaged
E. Pre Catalyst oxygen sensor is defective
F. Fuel rail/ injection hoses damaged/plugged

G. Base engine out of specification
H. ECU defective

1. Is the fuel level low?
    -No: Go to 2.
    -Yes: Replace fuel tank
2. Is the pre catalyst oxygen sensor connected?
    -Yes: Go to 3.
    -No: Connect and retest
3. Is the absolute fuel rail pressure greater than 2000 mBar and less than 3000 mBar at Key on?
    -Yes: Go to 4.
    -No: Ensure fuel shutoff valve is operating, if problem persists, replace regulator
4. Is the absolute fuel rail pressure greater than 1200 mBar and less than 2200 mBar at idle?
    -Yes: Go to 5.
    -No: Ensure manifold vacuum reference is connected to regulator, then replace gaseous fuel filter if problem persists
5. Test for continuity between O2 sensor connector Pins and Chassis Ground with Key Off.
    -Only Pin 1 is continuous: Go to 6.
    -Other Pins are continuous: Locate and rectify short in harness
6. Test harness continuity.
    -Continuities are Lambda 1 connector Pin 1 --- ECU M4
    Lambda 1 connector Pin 2 --- ECU L1
    Lambda 1 connector Pin 3 --- ECU M2
    Lambda 1 connector Pin 4 --- Engine Main Relay Receptacle B Pin 87
    : Go to 7.
    -Anything other than above: Locate and Rectify harness damage
7. Test ECU voltage outputs at oxygen sensor 1 connector at Key On with sensor disconnected.
    -Connector Lambda 1 connector Pin 1 is 0 +/- 0.5V
    Lambda 1 connector Pin 2 is 2 +/- 1V
    Lambda 1 connector Pin 3 is 0 +/- 0.5V
    Lambda 1 connector Pin 4 is battery V +/- 0.5V: Go to 8.
    -Voltage outputs out of specification: Check for shorts to battery voltage, replace ECU if none
8. Compare oxygen sensors 1 and 2 outputs using Juniper service tool at warm idle.
    -Both sensors are reading rich (greater than 450 mV) or lean (less than 450 mV) or are cycling through 450 mV: Go to 9.
    -One sensor is stuck lean (less than 450 mV) while the other is stuck rich (greater than 450 mV): Replace pre catalyst oxygen sensor
9. Check for fuel injector leakages using active diagnostic procedure in Juniper service tool.
    -Leakage is less than 10 mBar: Go to 10.
    -Leakage is greater than 10 mBar: Inspect gaseous fuel lines for leaks, replace fuel injector rail.
10. Compare short term fuel trim using Juniper service tool at idle with another fuel rail.
    -short term fuel trims differ by less than 0.20: Go to 11.
    -Short term fuel trims differ by more than 0.20: Replace fuel rail

11. Inspect whether base engine is within specification, including cylinder compression, intake/exhaust valve clearances, intake and exhaust leaks. Also verify PCV system.

- On older engines or those with poor oil maintenance assess the combustion blow (past piston rings) by at idle by pulling the PCV valve out of the valve cover (allowing fresh air to enter PCV valve and flow to intake manifold) and determine if the short term fuel trim changes by at least 15% indicating significantly increased airflow and better volumetric efficiency. If the blow-by is high at idle, piston rings and the cylinder walls may dictate an engine rebuild.

-Repair any issues found

DTC 2228: Barometric pressure circuit low
DTC 2229: Barometric pressure circuit high

Possible Causes
A. Defective ECU

1. Check barometric pressure using Juniper service tool.

-Reported barometric pressure differs from atmospheric pressure by more than 100 mBar: Replace ECU

DTC 2560: Engine coolant level low
May not be present on every Clark forklift

Possible Causes
A. Engine coolant level low
B. Coolant level sensor disconnected
C. Harness is shorted/damaged
D. Coolant level sensor damaged / defective
E. Defective ECU

1. Is the engine coolant level full?
   -Yes: Go to 2.
   -No: Fill coolant, perform air bleed procedure and test for DTC
2. Is the coolant level sensor connected?
   -Yes: Go to 3.
   -No: Reconnect and retest
3. Test the harness for continuity, shorts to ground or power, and continuity with ECU connector.

Test harness continuity.
-Continuities are Auxiliary Coolant Sensor Pin 1 --- ECU 17A (Vref)
Auxiliary Coolant Sensor Pin 2 --- ECU L1
-No shorts present, continuity between connector and ECU: Go to 4.
-Shorts present, or break in harness continuity: Repair and test again

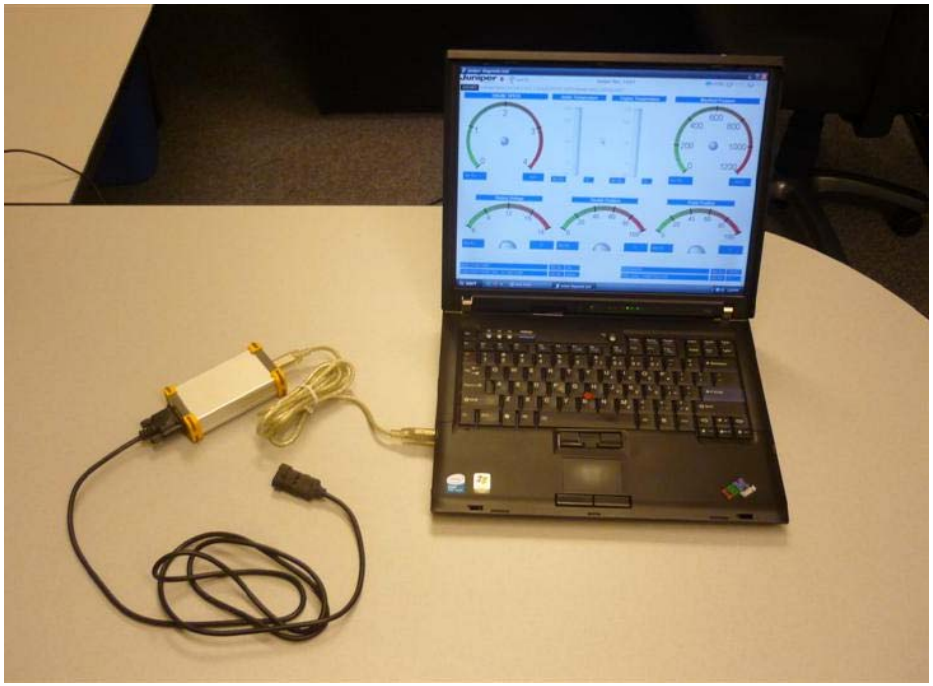
4. Test sensor connecter voltages at Key on with sensor disconnected.
   - ECU voltage outputs
     Auxiliary Coolant Sensor Pin 1 is 0V +/- 0.5 V
     Auxiliary Coolant Sensor Pin 2 is equal to voltage feed to sensor / dash light (i.e. 12 V approx.)

-Both voltages are within specification: Go to 5.
-Voltage at pin 1 is out of specification: Replace ECU

5. Disconnect and remove coolant level switch and test functionality in external water/coolant mixture with a multimeter.
-Determine if the switch does not function properly: If necessary, replace it.

9 DIAGNOSTIC SERVICE TOOL

- **Communication between the Engine Control Unit (ECU) and a computer can be established by using the Juniper Tool.**
- **The tool allows for a wide range of diagnostic functions and for easier identification of engine problems**
- **Simple to use and easy to read screens**



Tool Functions

- **Check real-time parameters**
- **Log real-time data at high speed (5Hz)**
- **Read Diagnostic Trouble Codes (DTC)**
  - Engine snapshot information available
  - Clear DTC command available
- **Perform active diagnostic routines**
  - Recalibrate throttle position sensors
  - Check for fuel leakages
- **Download calibrations and new software (Advanced version)**
- **Check engine information (hours, injections, average data, serial number, etc.)**

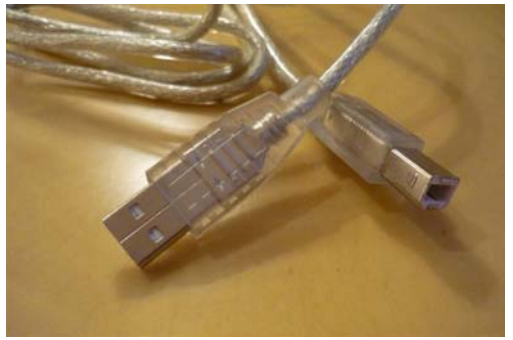
Tool Features

- **Four languages currently available**
  - English
  - Spanish
  - French
  - Portugese
- **Two access levels:**
  - Basic level, for common servicing
  - Advanced level, for dealers for calibration uploading: accessed with a password
- **Compatibility**
  - Windows Vista
  - Windows XP
  - Windows 2000
- **Units are Metric**

Components Required

- **Minimum Software Requirements**
  - PC with Windows Vista, XP or 2000
  - Minimum of 800x600 screen resolution
  - CD-ROM or DVD-ROM drive required

- **Juniper tool**



- **Standard USB A-B cable**

- **RS-232 to CAN cable**

Installing the Software and Driver

- **You must install the 1) Juniper Software, and 2) USB Connect Driver in order to connect the computer to the ECU**
- **Juniper Software Installation Instructions**

1. **Insert CD into computer**
2. **Click on “Start”, then “My Computer”**
3. **Double-click on “DVD/CD-RW Drive” or “CD Drive” (usually the D: Drive)**
4. **Double-click on “Juniper 1.0.0.1 INSTALL” directory**
5. **Double-click on “setup.exe”**
6. **Follow the instructions until software is successfully installed. The “Juniper” icon displayed here should appear on the desktop.**

Installing the Software and Driver

- **USB Connect Driver Installation Instructions**

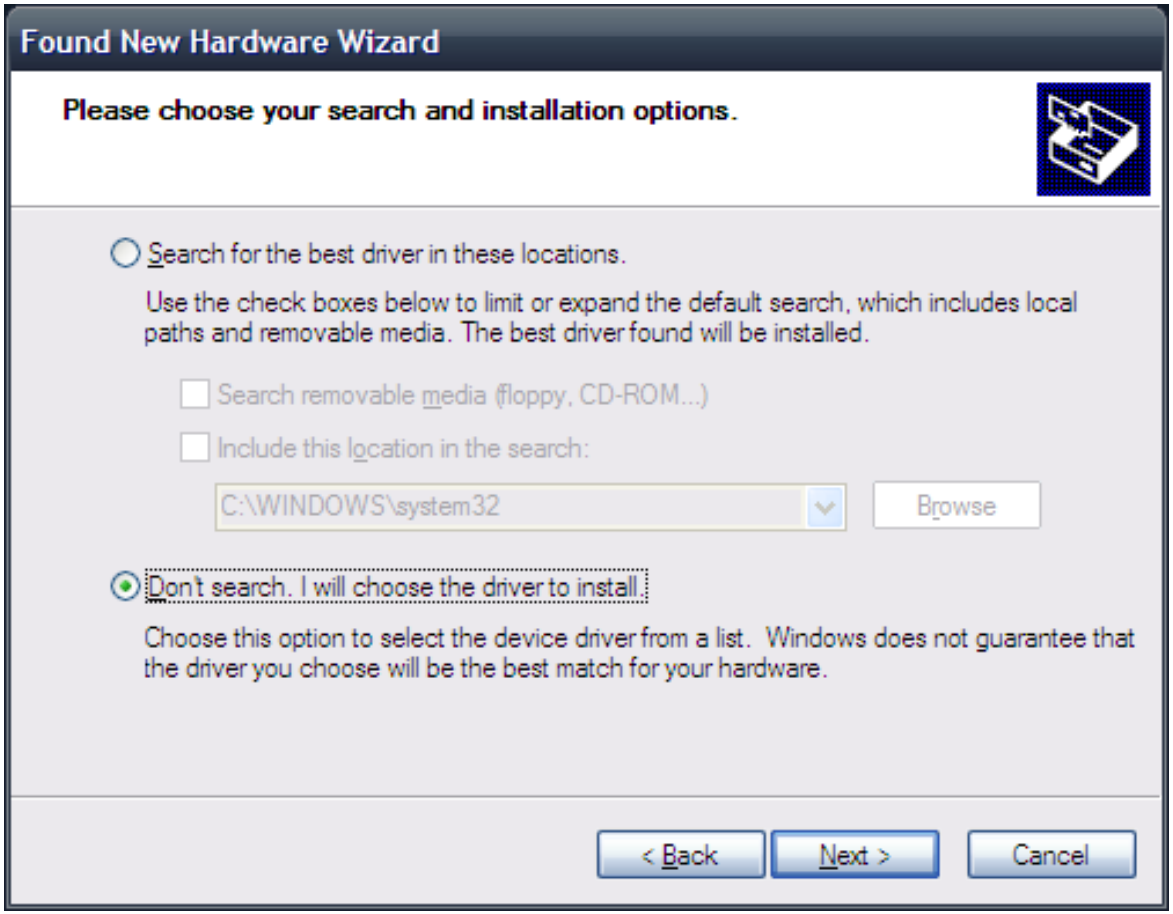
1. **Make sure the CD is still inserted in the computer**
2. **Plug one end of the USB cable into the Juniper Tool and the other end in a free USB port on your computer**
3. **The window below should appear. Select “Install from a list or specific location (Advanced)”, then click on “Next >”**

Found New Hardware Wizard
Welcome to the Found New Hardware Wizard
This wizard helps you install software for:
USBConnect - MTA interface
If your hardware came with an installation CD or floppy disk, insert it now.
What do you want the wizard to do?
Install the software automatically (Recommended)
Install from a list or specific location (Advanced)
Click Next to continue.
< Back
Next >
Cancel

Installing the Software and Driver

- **USB Connect Driver Installation Instructions**

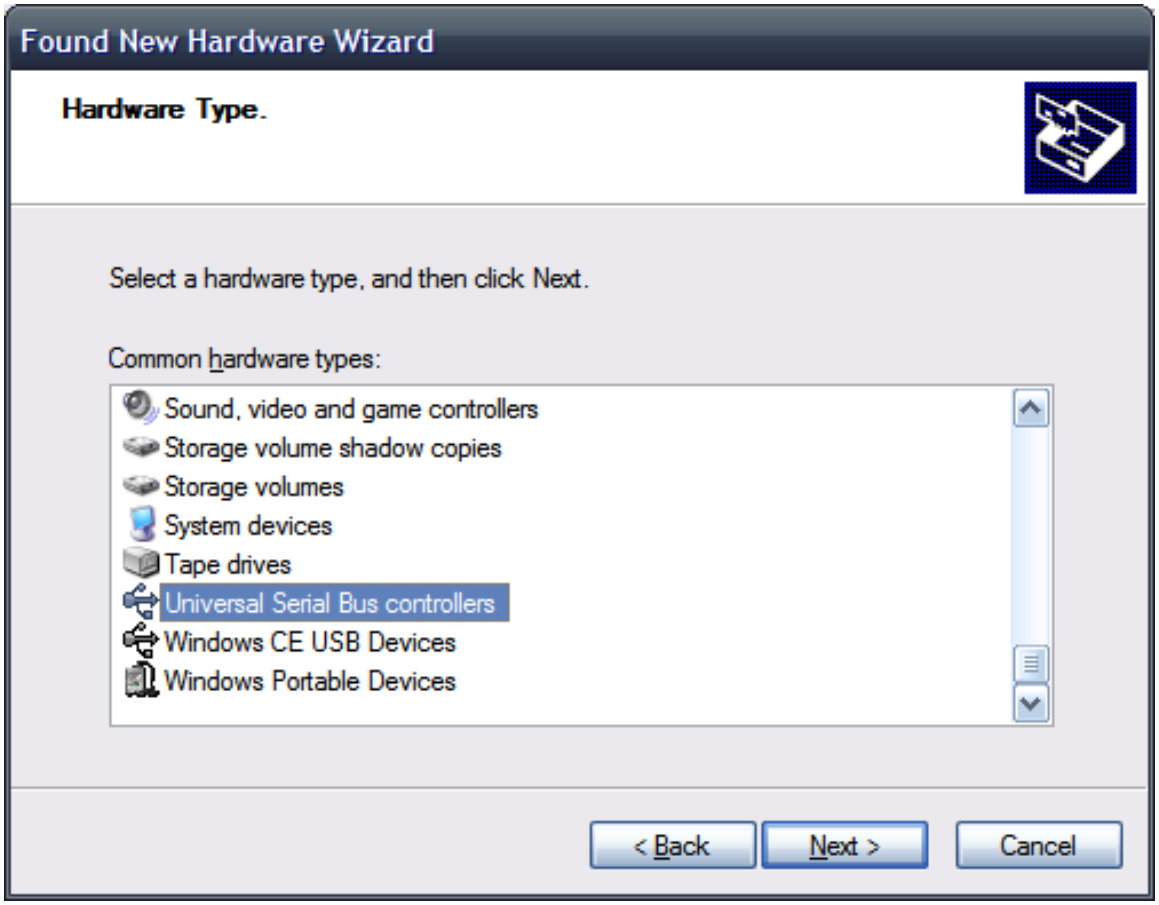
4. **Select “Don’t search. I will choose the driver to install”, then click on “Next >”**


Found New Hardware Wizard
Please choose your search and installation options.
Search for the best driver in these locations.
Use the check boxes below to limit or expand the default search, which includes local paths and removable media. The best driver found will be installed.
Search removable media (floppy, CD-ROM...)
Include this location in the search:
C:\WINDOWS\system32
Browse
Don't search. I will choose the driver to install.
Choose this option to select the device driver from a list. Windows does not guarantee that the driver you choose will be the best match for your hardware.
< Back
Next >
Cancel

Installing the Software and Driver

- **USB Connect Driver Installation Instructions**

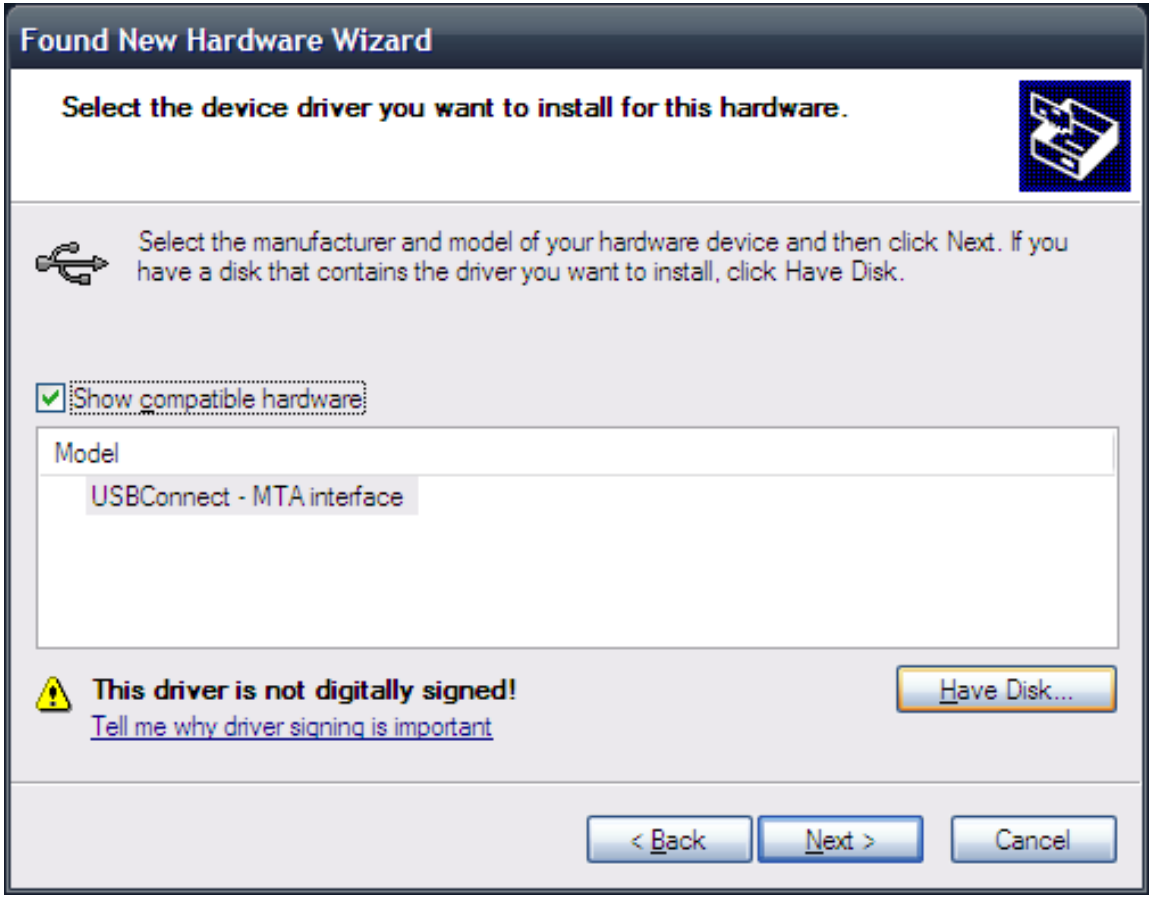
5. **In the list, scroll down, select “Universal Serial Bus controllers” and then click on “Next >”**



Installing the Software and Driver

❖ USB Connect Driver Installation Instructions

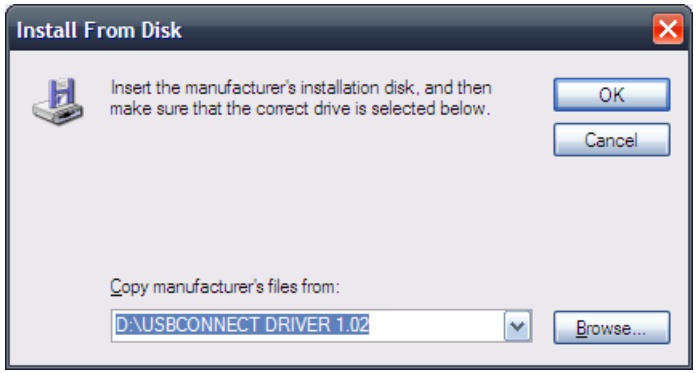
6. **Click on the “Have Disk” button**


Found New Hardware Wizard
Select the device driver you want to install for this hardware.
Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.
Show compatible hardware
Model
USBConnect - MTA interface
This driver is not digitally signed!
Tell me why driver signing is important
Have Disk...
< Back
Next >
Cancel

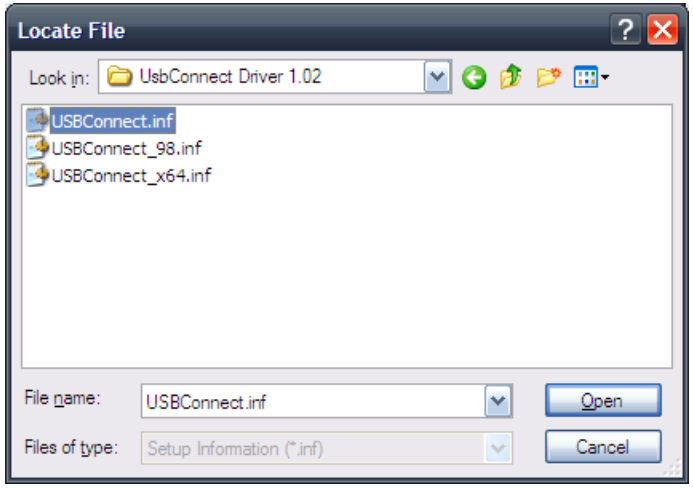
Installing the Software and Driver

- **USB Connect Driver Installation Instructions**

7. **Click on "Browse"**


Install From Disk
Insert the manufacturer's installation disk, and then make sure that the correct drive is selected below.
OK
Cancel
Copy manufacturer's files from:
D:\USBCONNECT DRIVER 1.02
Browse...

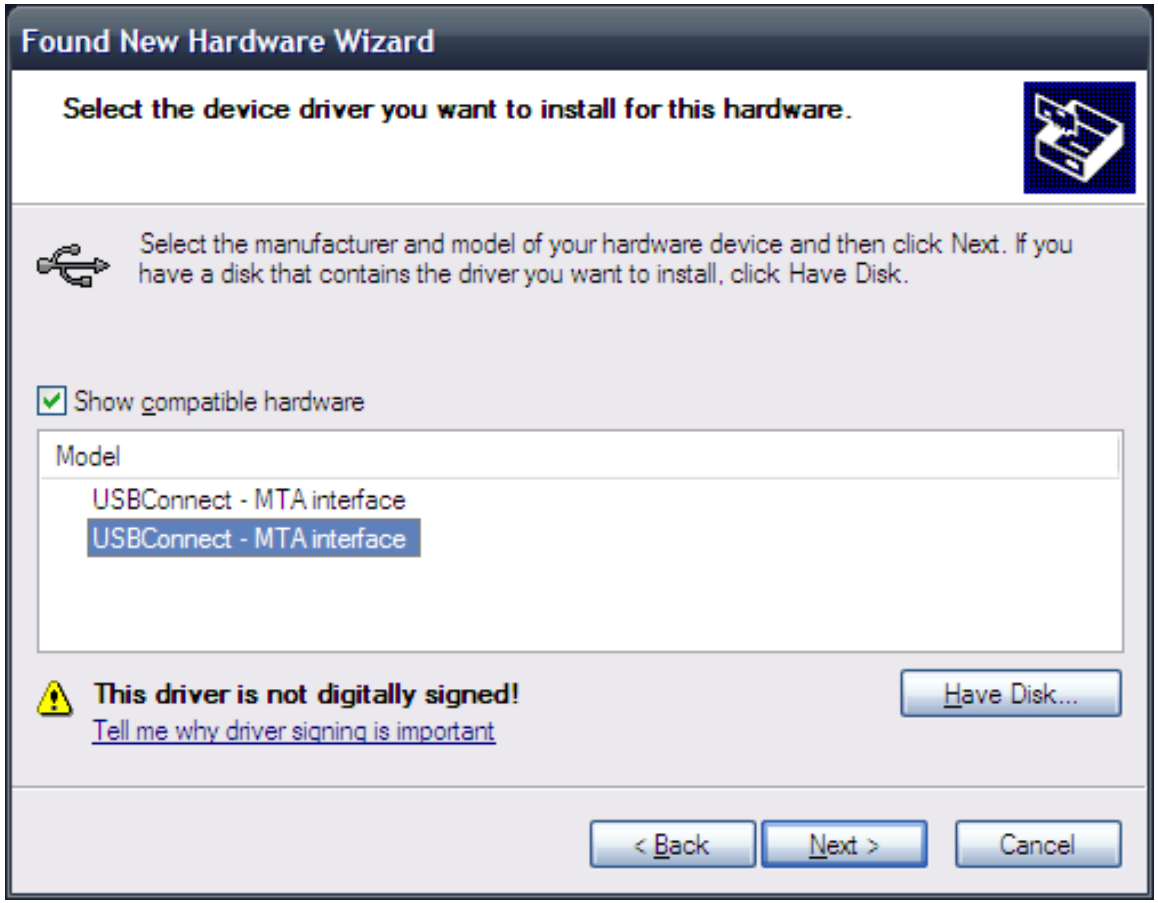
8. **Select the CD drive (usually D:) in "Look In", double-click on the "USBConnect Driver 1.02" directory, and select the first file. If you are using Windows 98, use the second file. If you are using Windows XP 64-bit edition, use the third file.**



Installing the Software and Driver

- **USB Connect Driver Installation Instructions**

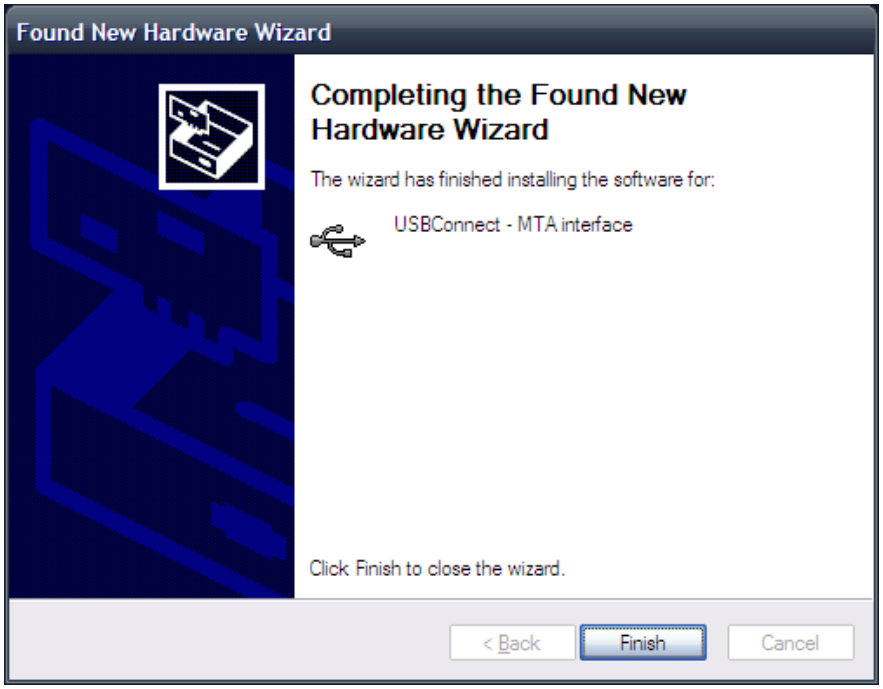
9. **Select the second "USBConnect – MTA interface" option, then click on "Next >"**


Found New Hardware Wizard
Select the device driver you want to install for this hardware.
Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.
Show compatible hardware
Model
USBConnect - MTA interface
USBConnect - MTA interface
This driver is not digitally signed!
Tell me why driver signing is important
Have Disk...
< Back
Next >
Cancel

Installing the Software and Driver

- **USB Connect Driver Installation Instructions**

10. **The PC will start installing the driver. When the window below appears, click on "Finish" and the driver installation will be complete**

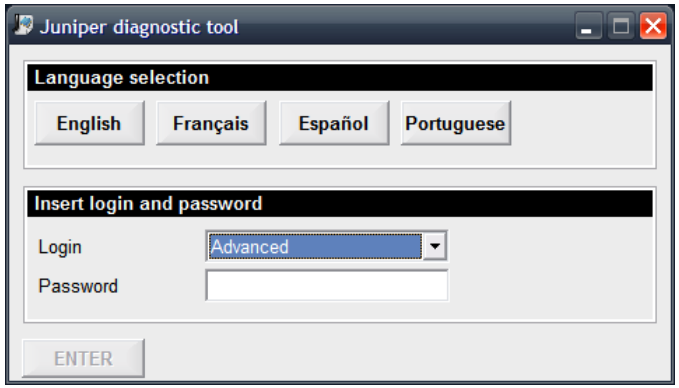

Found New Hardware Wizard
Completing the Found New Hardware Wizard
The wizard has finished installing the software for:
USBConnect - MTA interface
Click Finish to close the wizard.
< Back
Finish
Cancel

***Note that if you want to use other USB ports on your computer in the future, you may need to repeat the process for each port

Starting the Program and Logging In

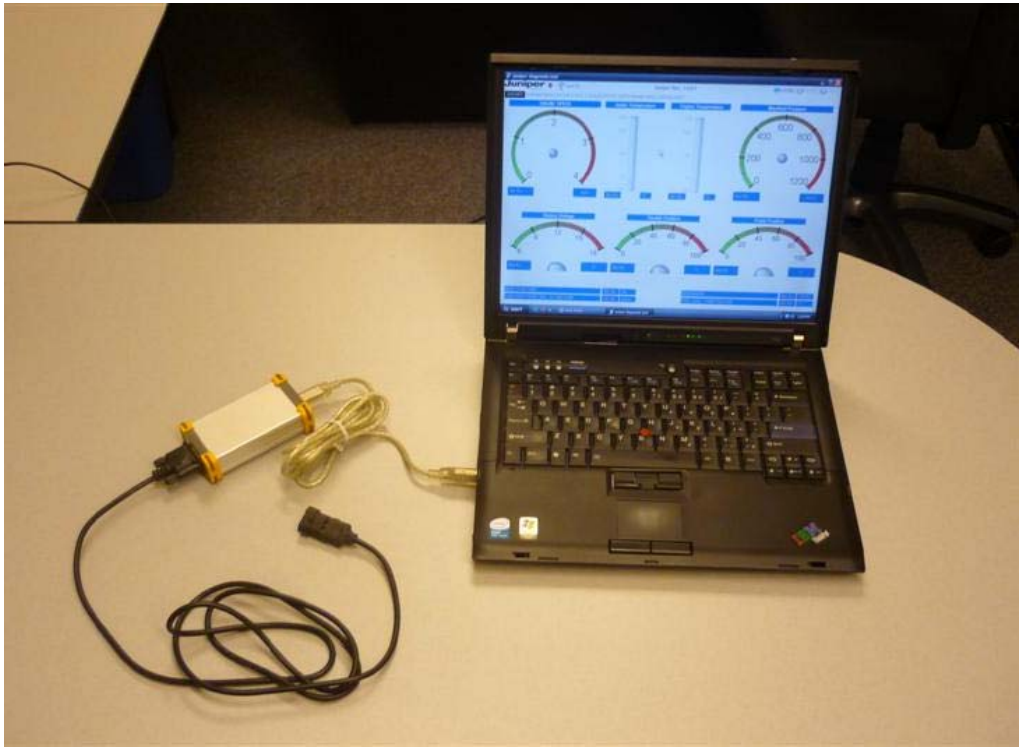
- **You can start the program two ways:**
  1. Using the Start Menu: Start→All Programs→Juniper→Juniper
  2. Using the desktop shortcut icon labeled “Juniper”

- **The logo screen (shown below) will prompt you for a language, login level, and password (if needed)**
  - There are three access levels:
    - **Basic** *(no password)*: General access to read data, clear DTCs, perform diagnostic routines
    - **Advanced** *(password required)*: All of the above, plus the ability to edit ECU parameters, and load new software/calibrations.
    - **EOL** *(password required)*: End-of-line access for Juniper factory use only.

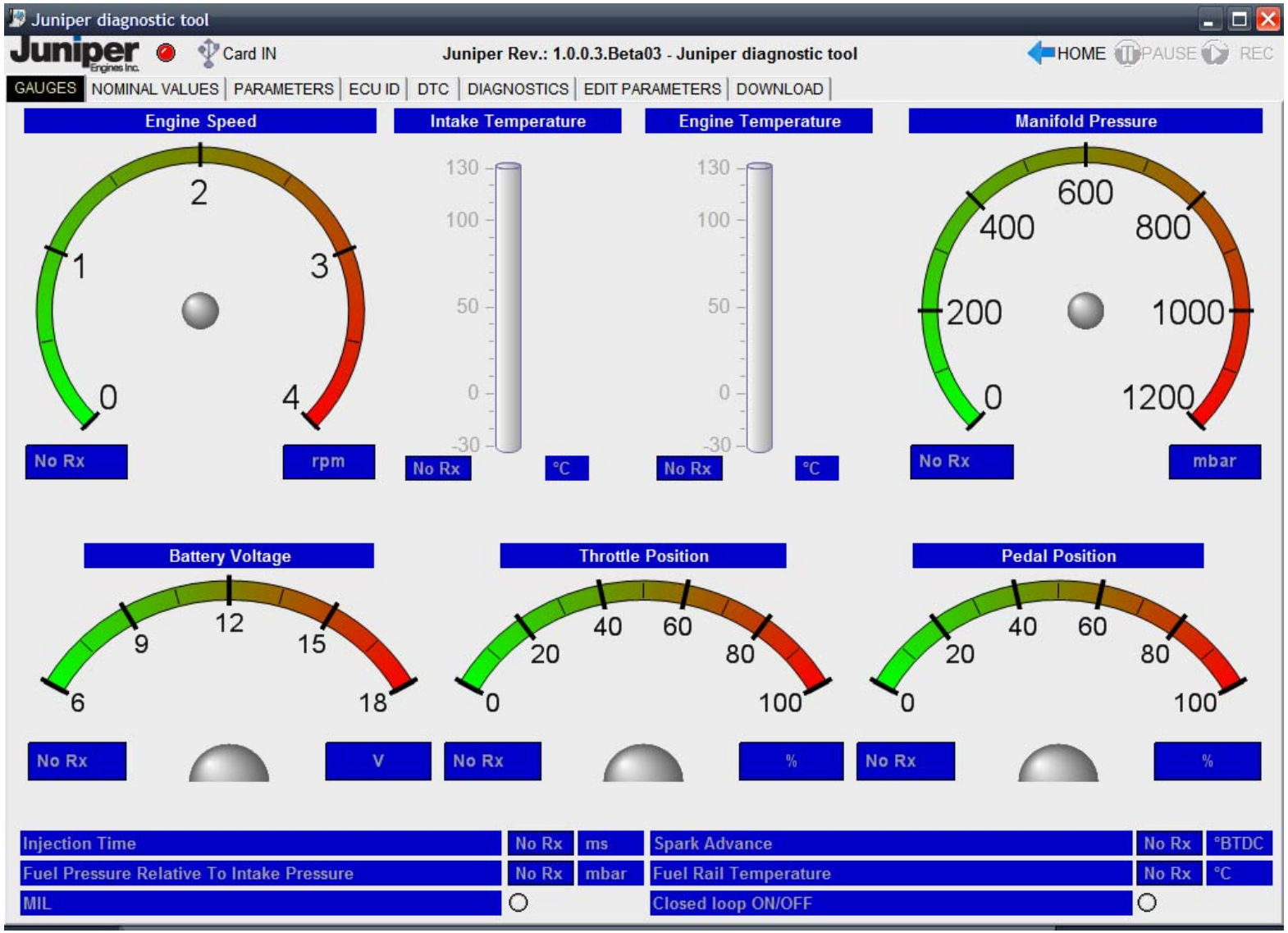


Connecting to the ECU

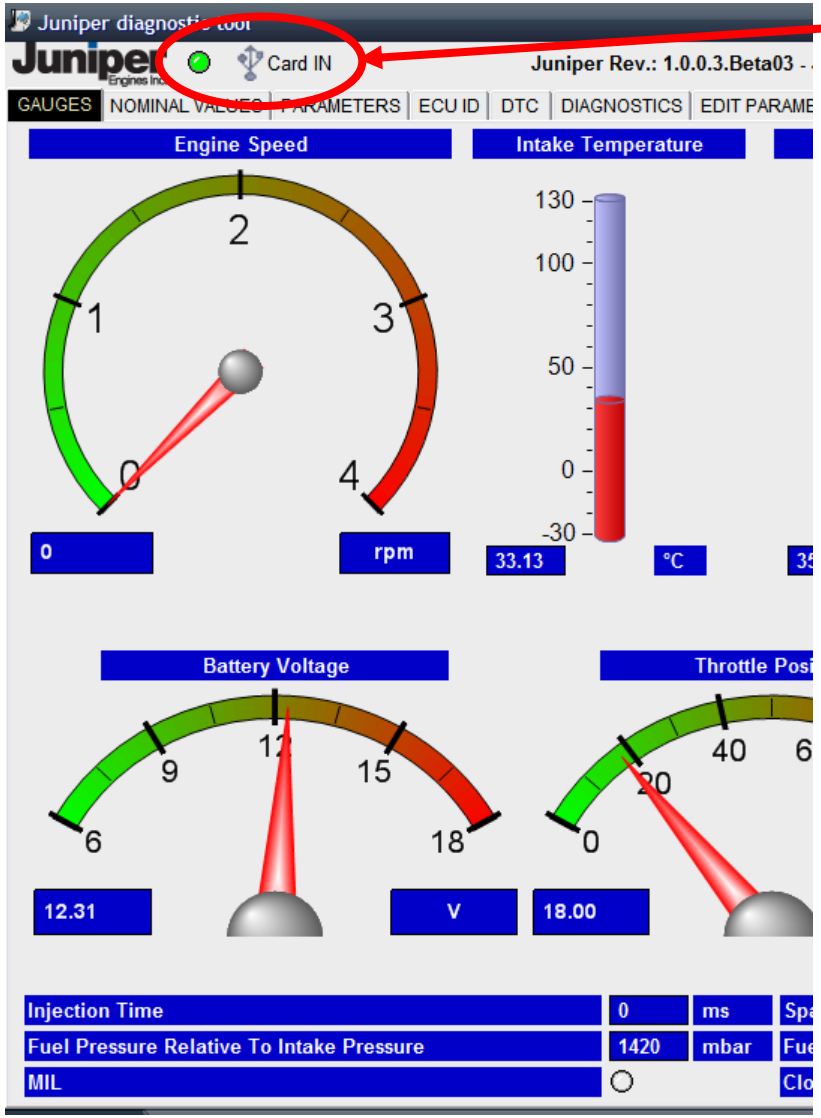
- To connect to the ECU, connect the Juniper Tool to the computer using the USB cable, then use the RS-232 to CAN cable to connect the other end to the harness
- The program will be connected as soon as the ignition is turned on, and up to one minute after the ignition is turned off



Gauges Tab: Main Screen (Not Connected)



Gauges Tab: Connecting to Engine



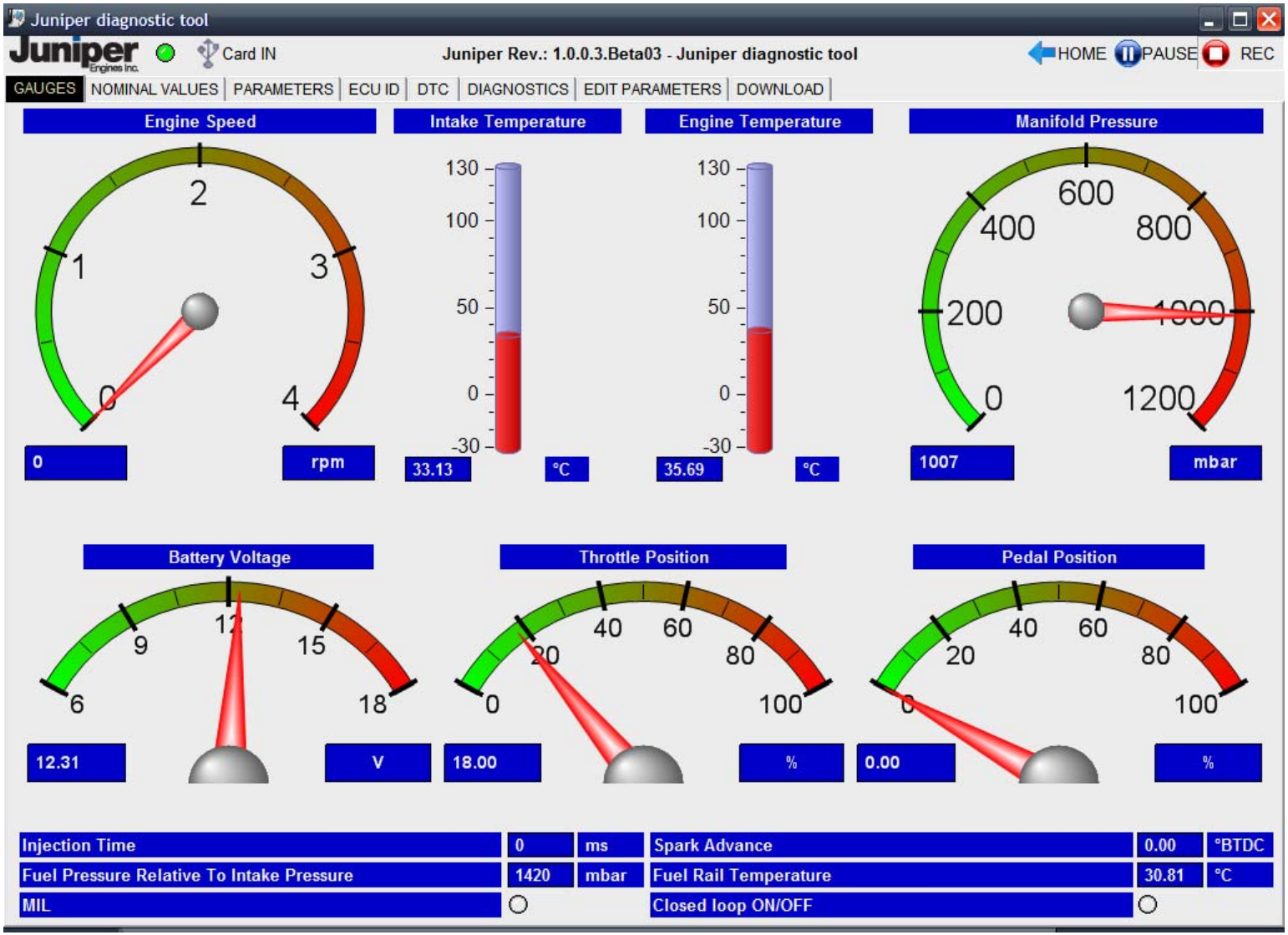
Tool and ECU connection status

Tool not connected and ECU not linked to computer

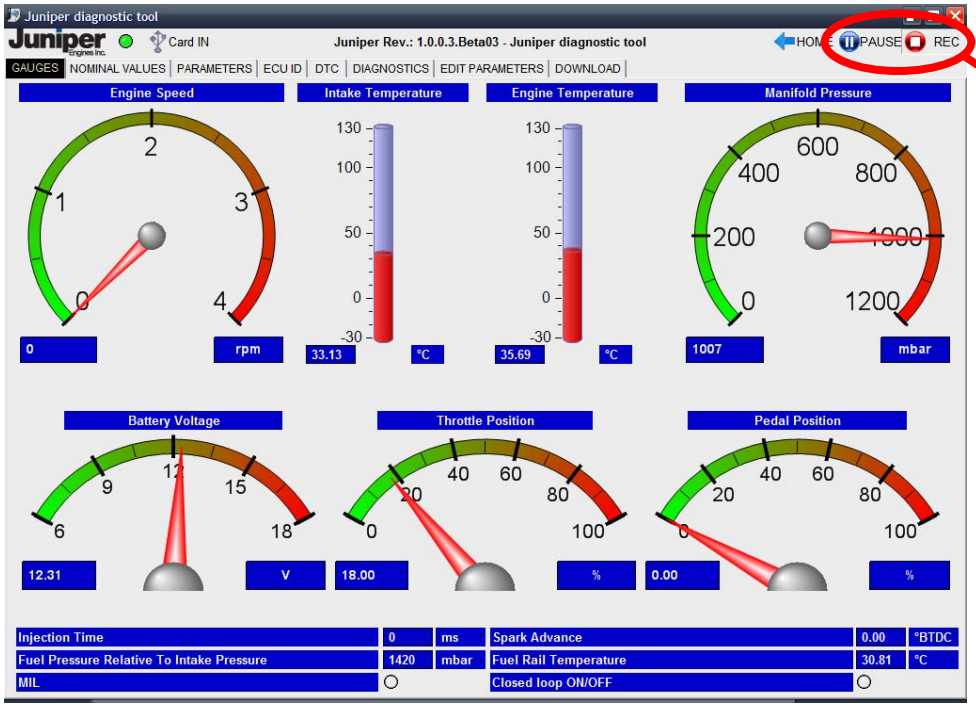
Tool connected with computer but ECU not linked with tool

Tool connected and ECU linked to computer

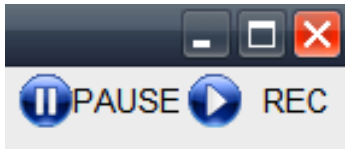
Gauges Tab: Main Screen (Connected)



Gauges Tab: Logging ECU Data

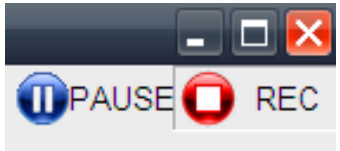


Logging Controls



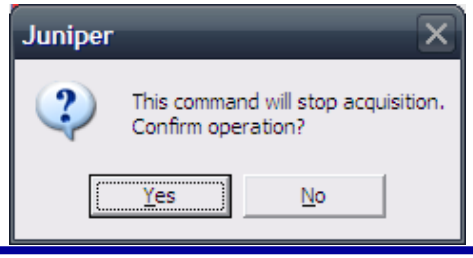
Pause Screen Updating

Start Recording



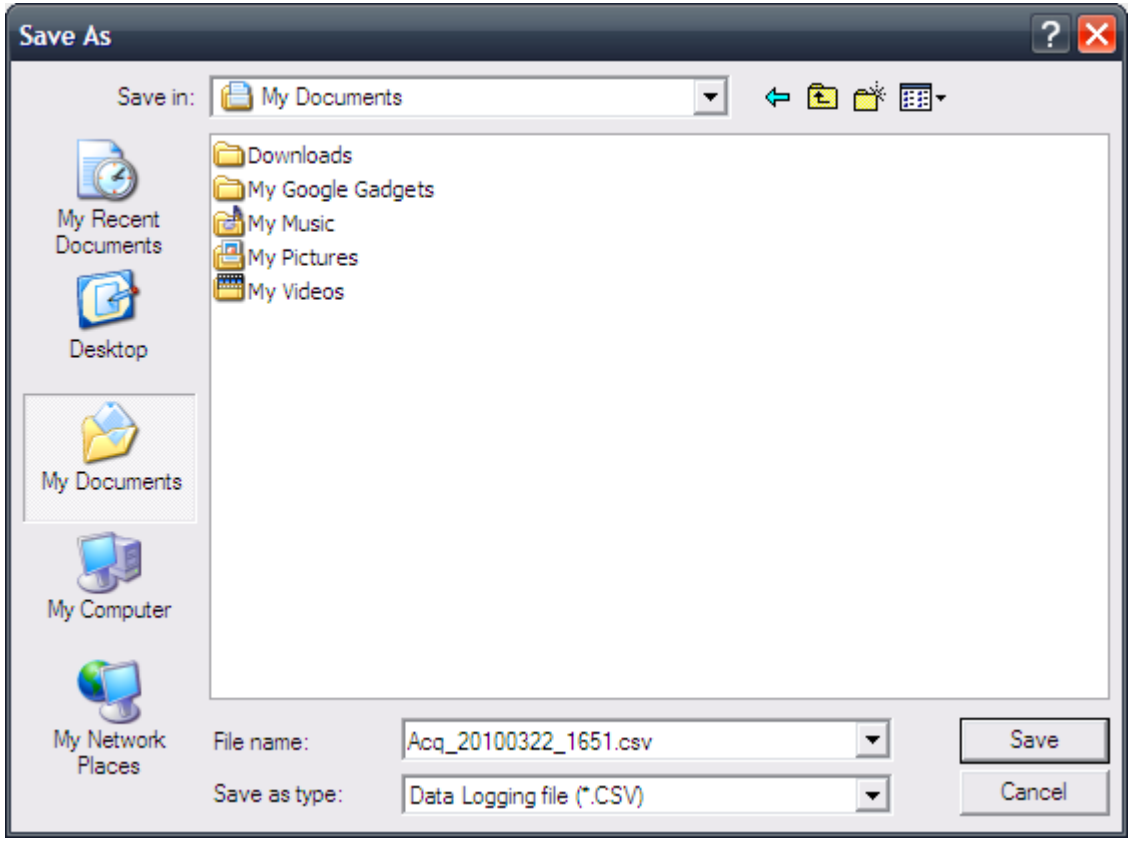
Stop Recording

- **When logging commences, "REC" button changes from a blue button with a triangle to a red button with a square.**
- **To stop logging, click on the red button. A prompt will ask for confirmation to end the acquisition.**



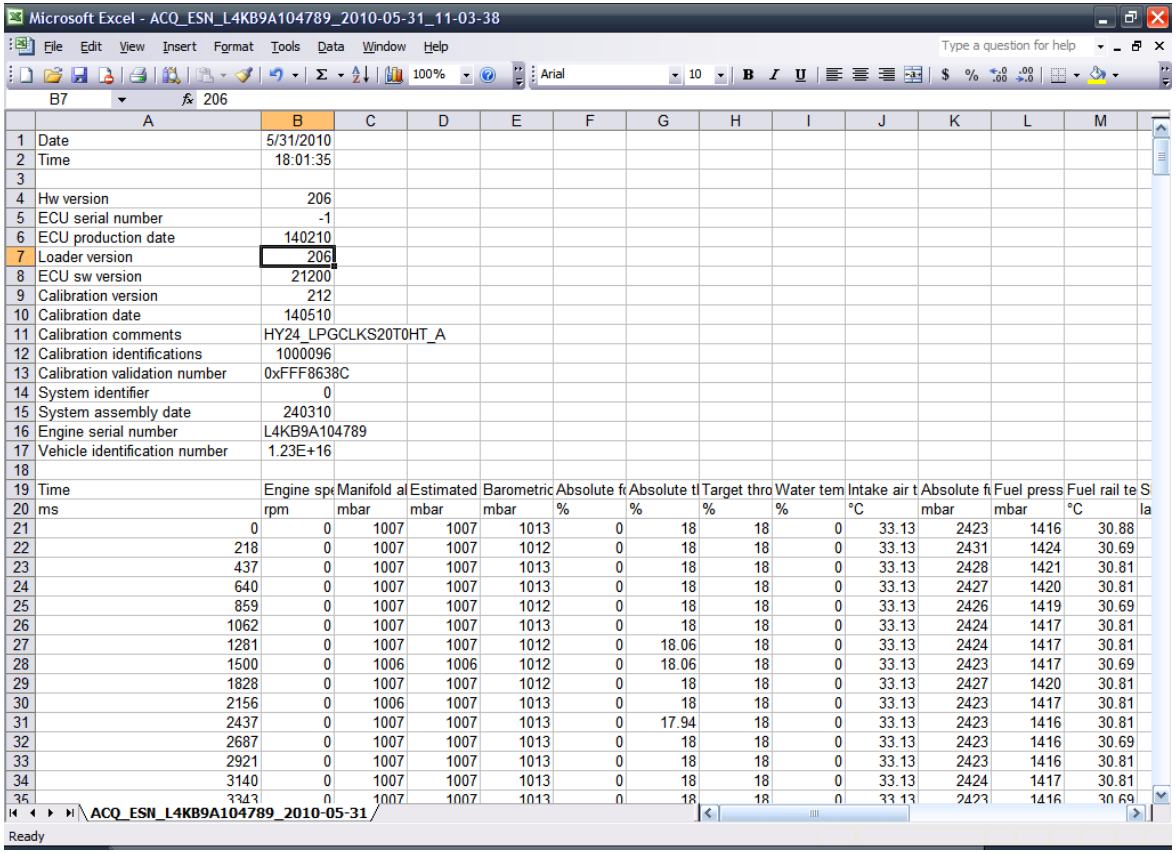
Gauges Tab: Logging ECU Data

- **The user will then be prompted for a save location.**
- **Save the file in a location that is easy to remember, such as the Desktop or My Documents so that it can be accessed later.**



Gauges Tab: Logging ECU Data (2)

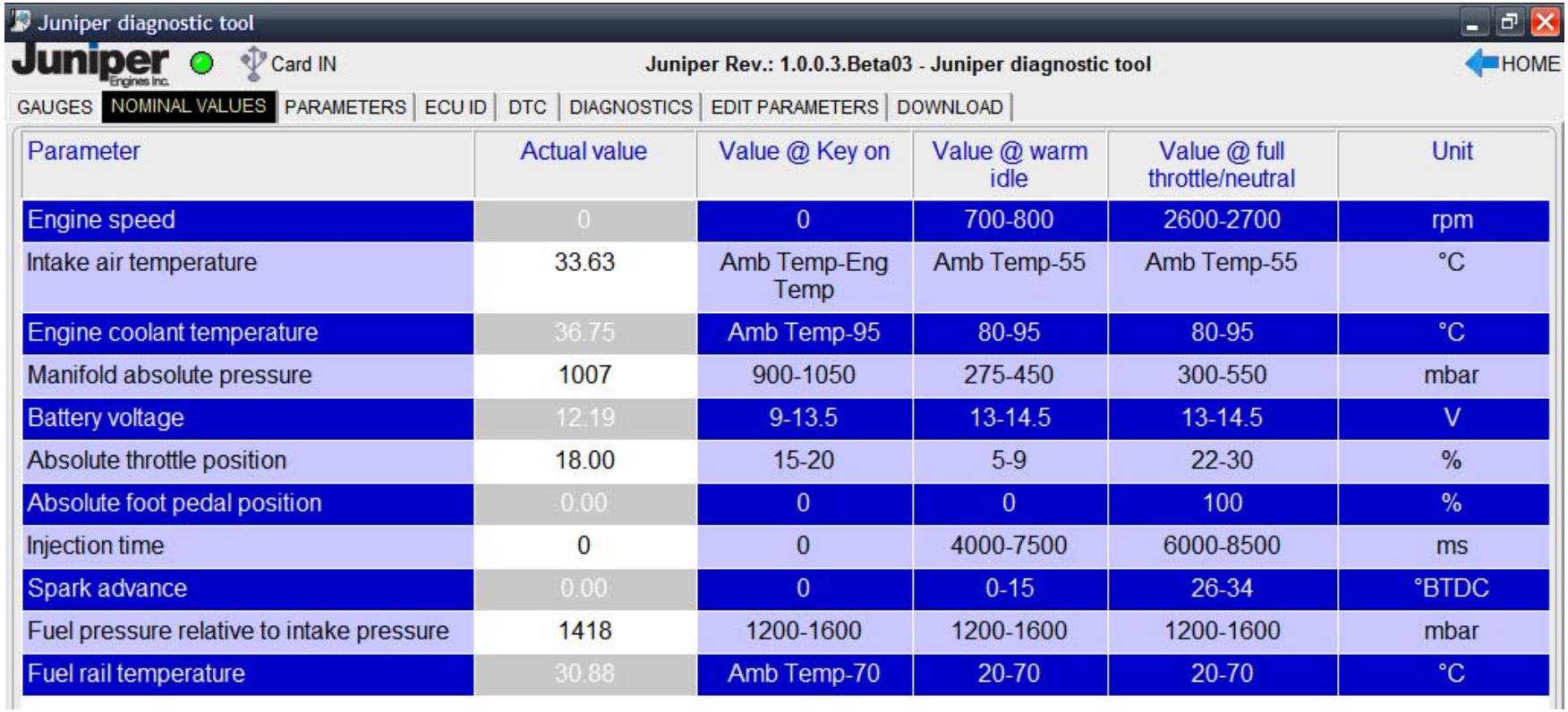
- The log file is in Comma Separated Value format, or CSV
- This format is easily opened by Microsoft Excel, Open Office Calc or any other spreadsheet program



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Date	5/31/2010											
2	Time	18:01:35											
3													
4	Hw version	206											
5	ECU serial number	-1											
6	ECU production date	140210											
7	Loader version	206											
8	ECU sw version	21200											
9	Calibration version	212											
10	Calibration date	140510											
11	Calibration comments	HY24_LPGCLKS20T0HT_A											
12	Calibration identifications	1000096											
13	Calibration validation number	0xFFF8638C											
14	System identifier	0											
15	System assembly date	240310											
16	Engine serial number	L4KB9A104789											
17	Vehicle identification number	1.23E+16											
18													
19	Time	Engine spe	Manifold al	Estimated	Barometric	Absolute fu	Absolute th	Target thro	Water tem	Intake air t	Absolute fu	Fuel press	Fuel rail te	S
20	ms	rpm	mbar	mbar	mbar	%	%	%	%	°C	mbar	mbar	°C	la
21	0	0	1007	1007	1013	0	18	18	0	33.13	2423	1416	30.88	
22	218	0	1007	1007	1012	0	18	18	0	33.13	2431	1424	30.69	
23	437	0	1007	1007	1013	0	18	18	0	33.13	2428	1421	30.81	
24	640	0	1007	1007	1013	0	18	18	0	33.13	2427	1420	30.81	
25	859	0	1007	1007	1012	0	18	18	0	33.13	2426	1419	30.69	
26	1062	0	1007	1007	1013	0	18	18	0	33.13	2424	1417	30.81	
27	1281	0	1007	1007	1012	0	18.06	18	0	33.13	2424	1417	30.81	
28	1500	0	1006	1006	1012	0	18.06	18	0	33.13	2423	1417	30.69	
29	1828	0	1007	1007	1012	0	18	18	0	33.13	2427	1420	30.81	
30	2156	0	1006	1007	1013	0	18	18	0	33.13	2423	1417	30.81	
31	2437	0	1007	1007	1013	0	17.94	18	0	33.13	2423	1416	30.81	
32	2687	0	1007	1007	1013	0	18	18	0	33.13	2423	1416	30.69	
33	2921	0	1007	1007	1013	0	18	18	0	33.13	2423	1416	30.81	
34	3140	0	1007	1007	1013	0	18	18	0	33.13	2424	1417	30.81	
35	3343	0	1007	1007	1013	0	18	18	0	33.13	2423	1416	30.69	

Nominal Values Tab

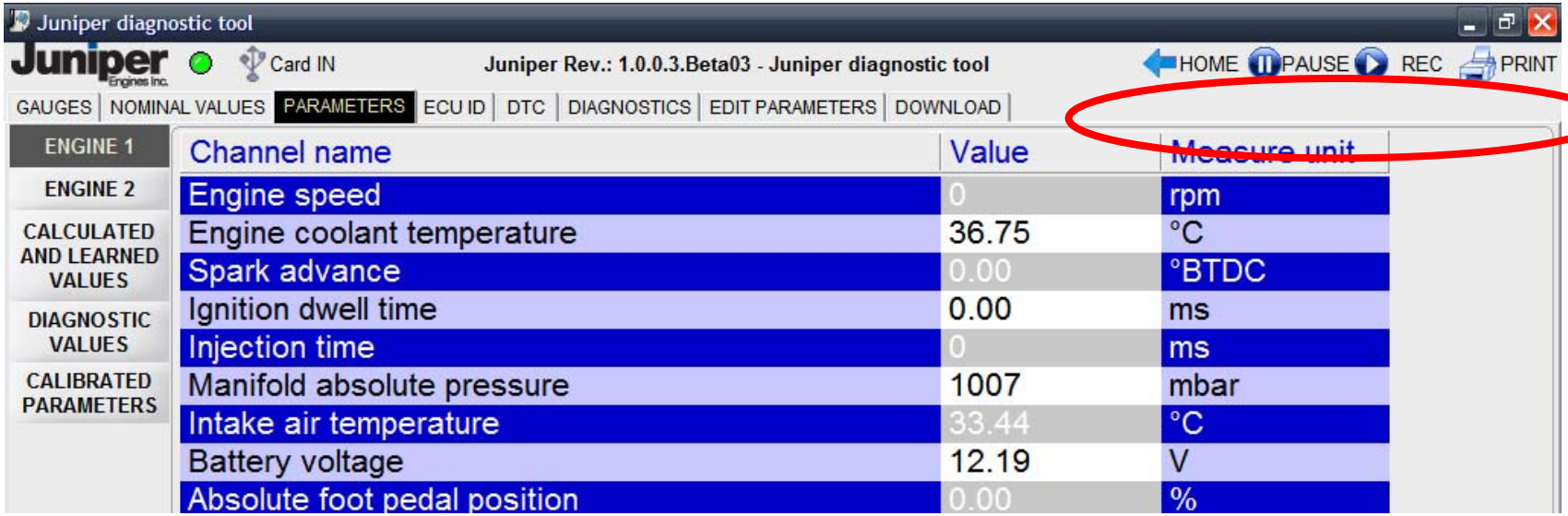
- **This page familiarizes the user with typical values that should be seen when the engine is on**



Parameter	Actual value	Value @ Key on	Value @ warm idle	Value @ full throttle/neutral	Unit
Engine speed	0	0	700-800	2600-2700	rpm
Intake air temperature	33.63	Amb Temp-Eng Temp	Amb Temp-55	Amb Temp-55	°C
Engine coolant temperature	36.75	Amb Temp-95	80-95	80-95	°C
Manifold absolute pressure	1007	900-1050	275-450	300-550	mbar
Battery voltage	12.19	9-13.5	13-14.5	13-14.5	V
Absolute throttle position	18.00	15-20	5-9	22-30	%
Absolute foot pedal position	0.00	0	0	100	%
Injection time	0	0	4000-7500	6000-8500	ms
Spark advance	0.00	0	0-15	26-34	°BTDC
Fuel pressure relative to intake pressure	1418	1200-1600	1200-1600	1200-1600	mbar
Fuel rail temperature	30.88	Amb Temp-70	20-70	20-70	°C

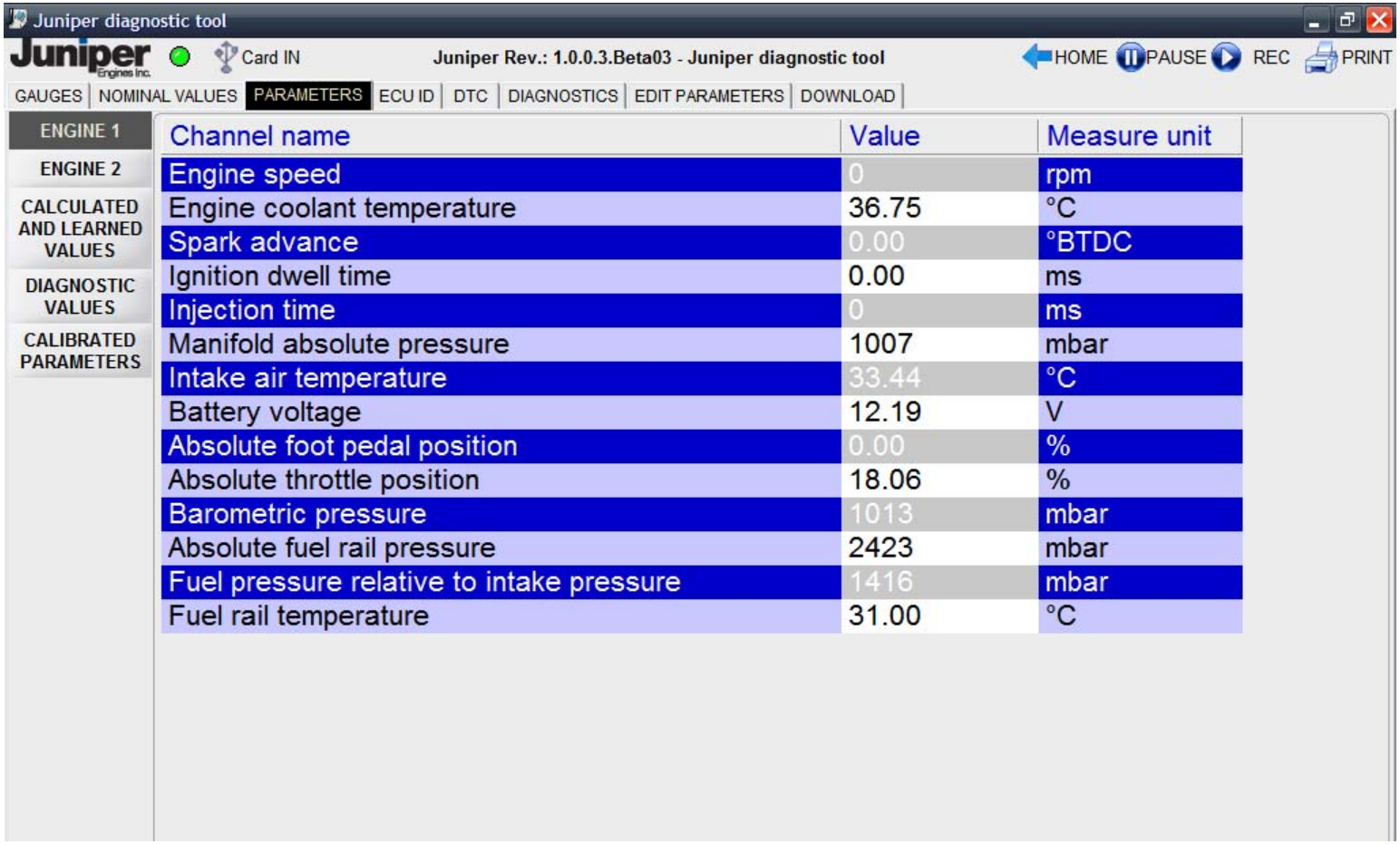
Parameters Tab

- The “Parameters” tab allows the user to see various real-time engine parameters
- You can pause the automatic refreshing of the screen by using the pause button.
- The logging function is exactly like the “Gauges” tab
- A print function is also available to print a snapshot of the values of the current page directly to an attached printer



Parameters Tab: Engine 1

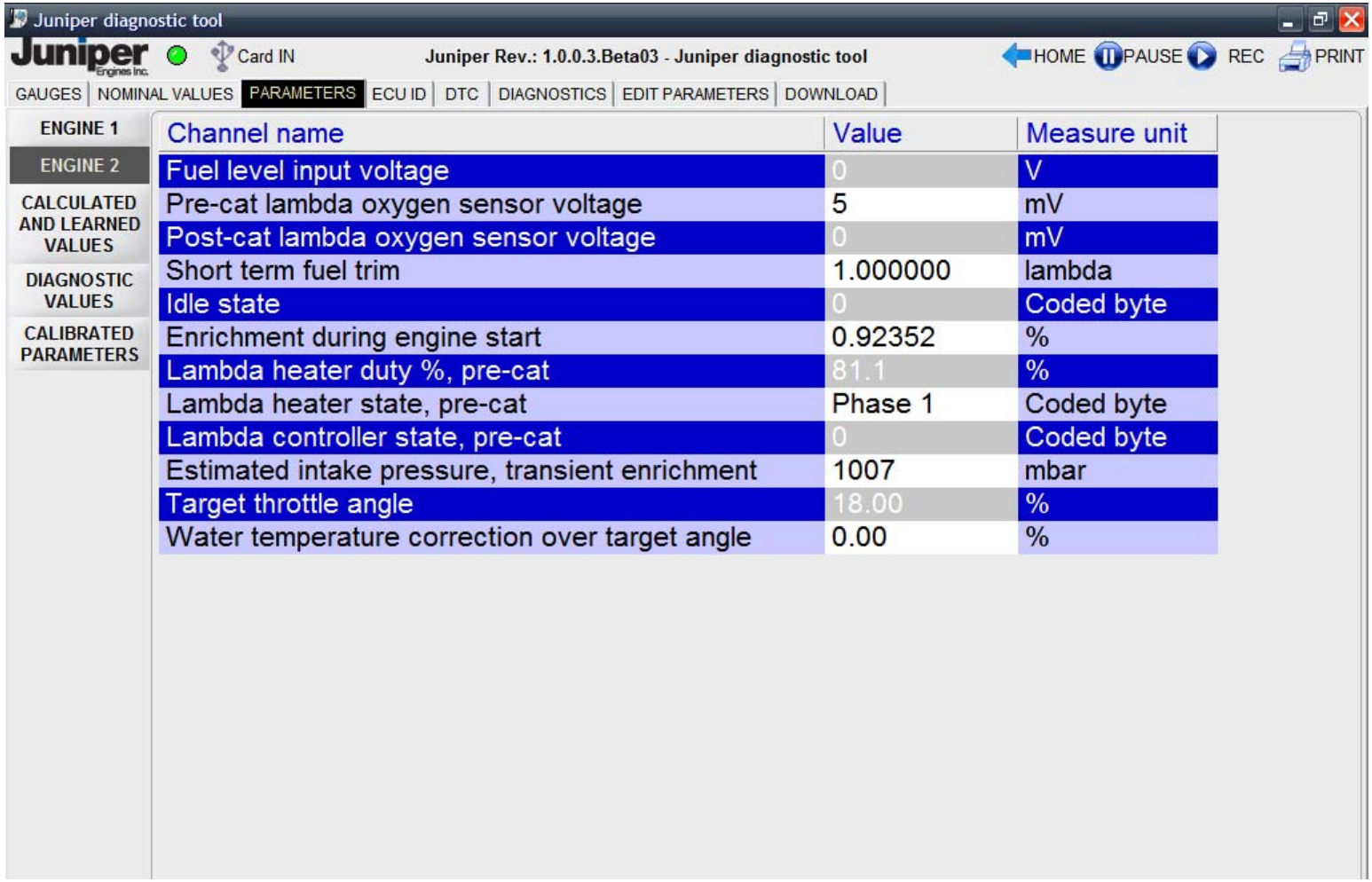
- **Basic real-time parameters from the ECU and engine sensors**



Channel name	Value	Measure unit
Engine speed	0	rpm
Engine coolant temperature	36.75	°C
Spark advance	0.00	°BTDC
Ignition dwell time	0.00	ms
Injection time	0	ms
Manifold absolute pressure	1007	mbar
Intake air temperature	33.44	°C
Battery voltage	12.19	V
Absolute foot pedal position	0.00	%
Absolute throttle position	18.06	%
Barometric pressure	1013	mbar
Absolute fuel rail pressure	2423	mbar
Fuel pressure relative to intake pressure	1416	mbar
Fuel rail temperature	31.00	°C

Parameters Tab: Engine 2

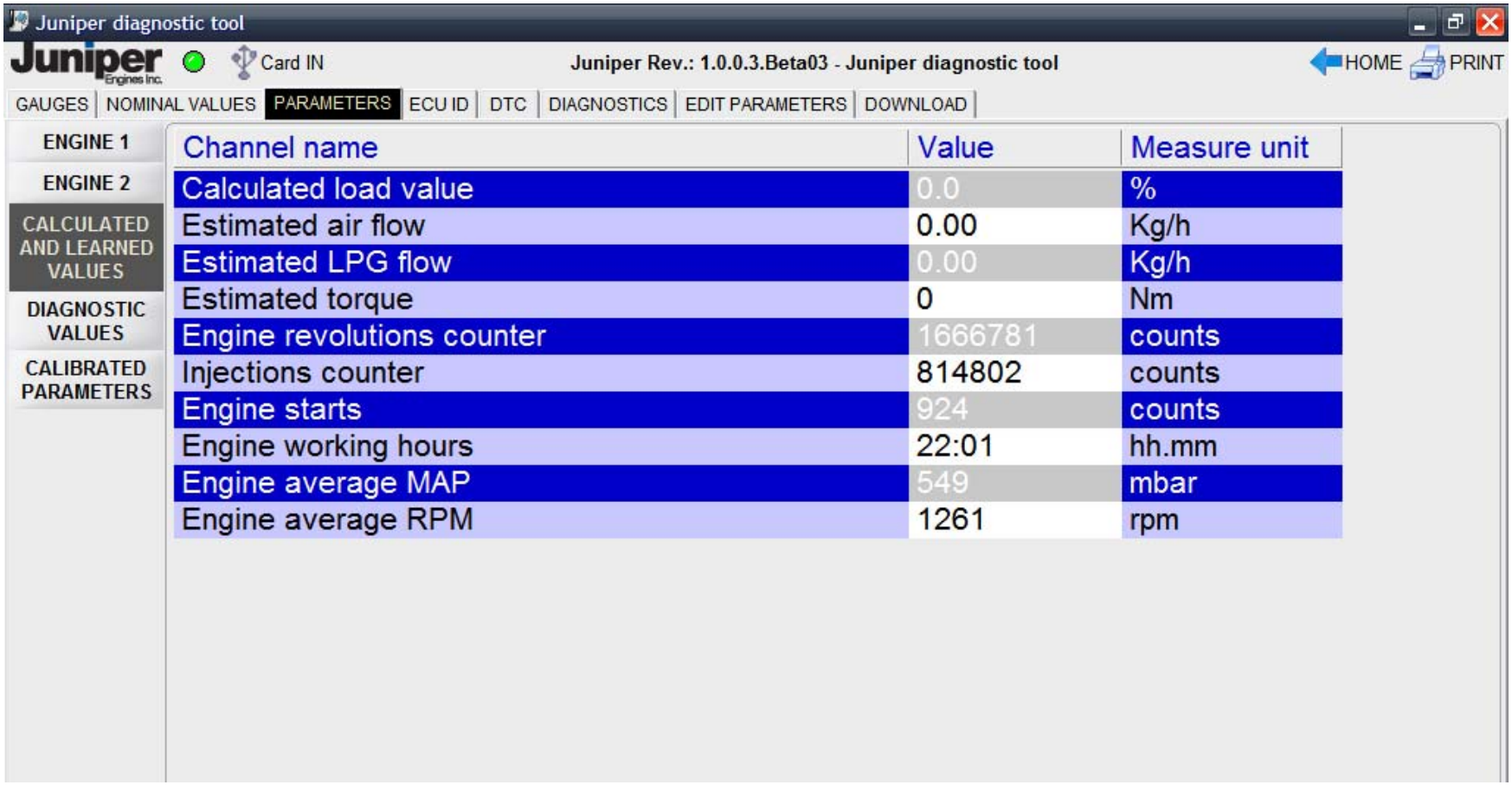
- **Basic real-time parameters from the ECU and engine sensors**



Channel name	Value	Measure unit
Fuel level input voltage	0	V
Pre-cat lambda oxygen sensor voltage	5	mV
Post-cat lambda oxygen sensor voltage	0	mV
Short term fuel trim	1.000000	lambda
Idle state	0	Coded byte
Enrichment during engine start	0.92352	%
Lambda heater duty %, pre-cat	81.1	%
Lambda heater state, pre-cat	Phase 1	Coded byte
Lambda controller state, pre-cat	0	Coded byte
Estimated intake pressure, transient enrichment	1007	mbar
Target throttle angle	18.00	%
Water temperature correction over target angle	0.00	%

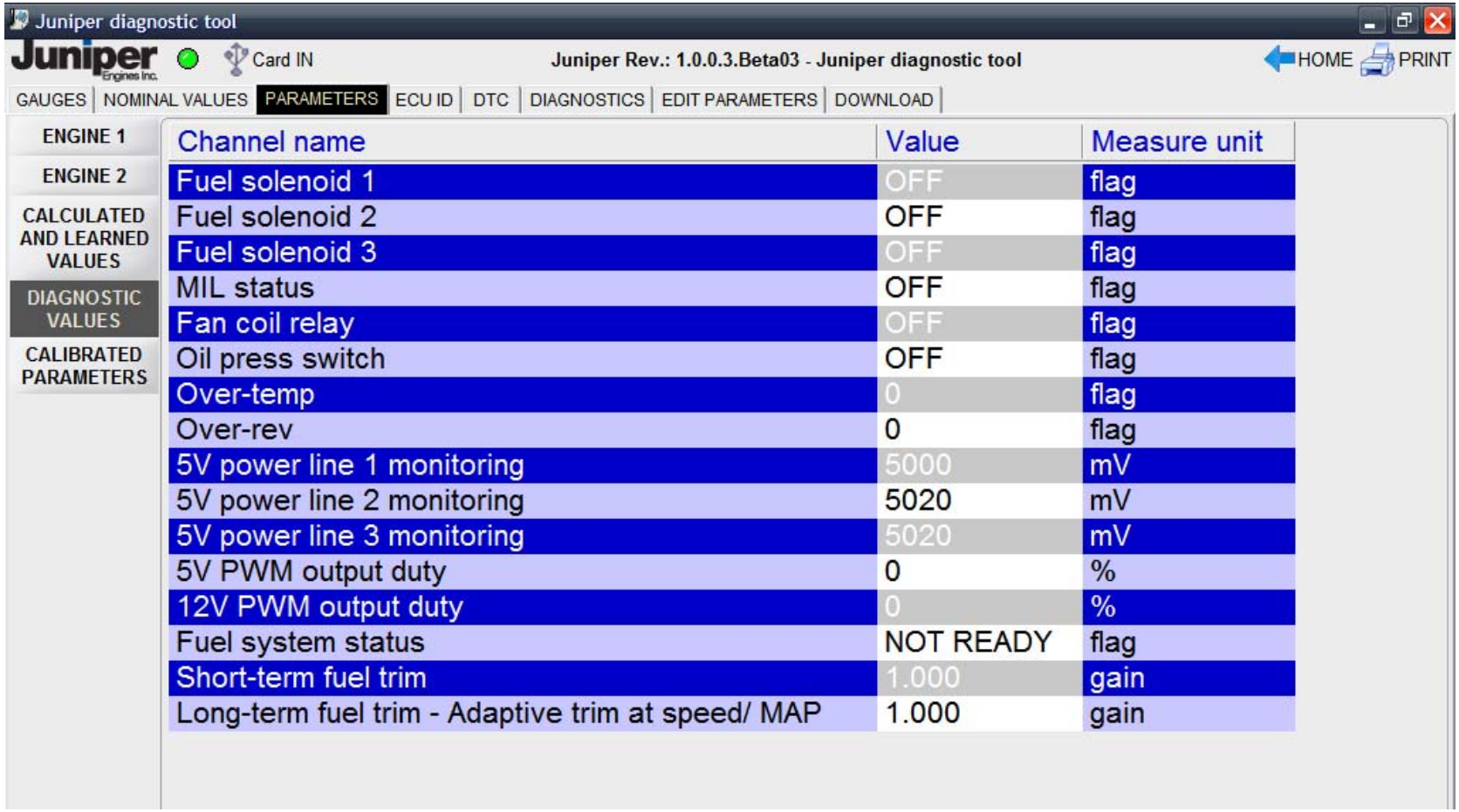
Parameters Tab: Calculated and Learned Values

- **These values are calculated or estimated by the ECU based on look-up data or previous operation**



Parameters Tab: Diagnostic Values

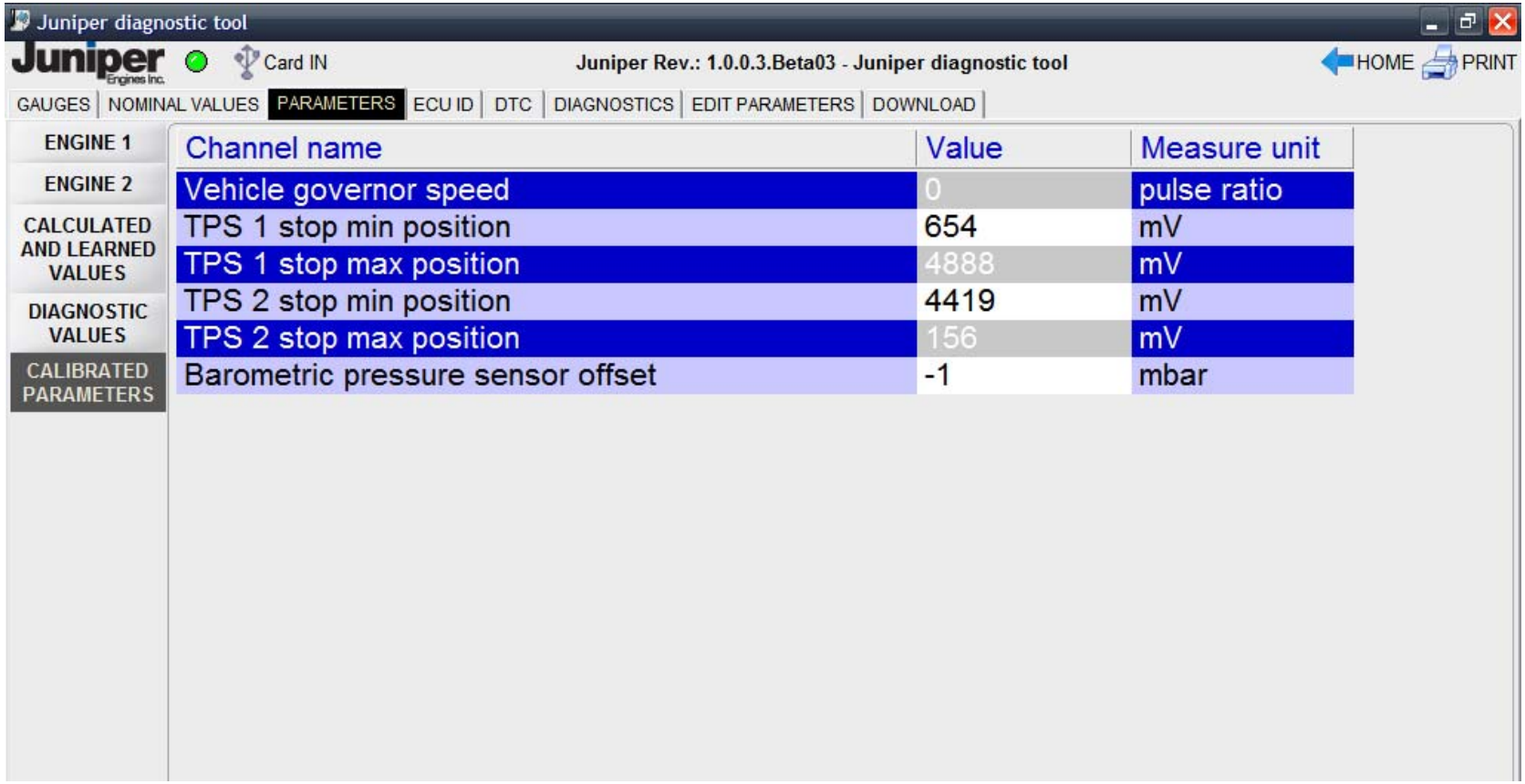
- **These are values that are relevant to the On-Board Diagnostic (OBD) system of the forklift**



Channel name	Value	Measure unit
Fuel solenoid 1	OFF	flag
Fuel solenoid 2	OFF	flag
Fuel solenoid 3	OFF	flag
MIL status	OFF	flag
Fan coil relay	OFF	flag
Oil press switch	OFF	flag
Over-temp	0	flag
Over-rev	0	flag
5V power line 1 monitoring	5000	mV
5V power line 2 monitoring	5020	mV
5V power line 3 monitoring	5020	mV
5V PWM output duty	0	%
12V PWM output duty	0	%
Fuel system status	NOT READY	flag
Short-term fuel trim	1.000	gain
Long-term fuel trim - Adaptive trim at speed/ MAP	1.000	gain

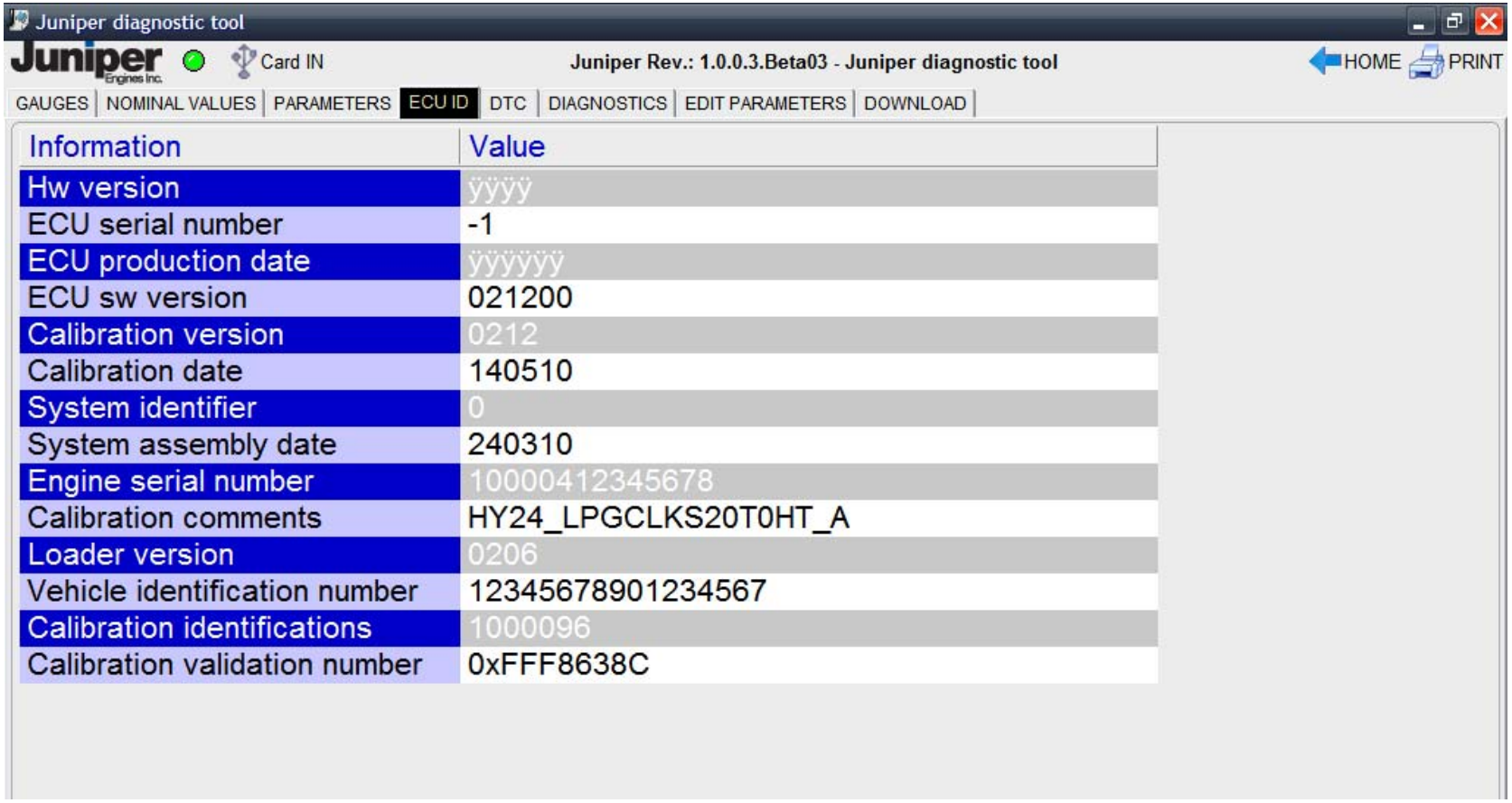
Parameters Tab: Calibrated Parameters

- **These are parameters that are determined by manual calibration or by ECU calibration routines**



ECU ID Tab: ECU Identification and Information

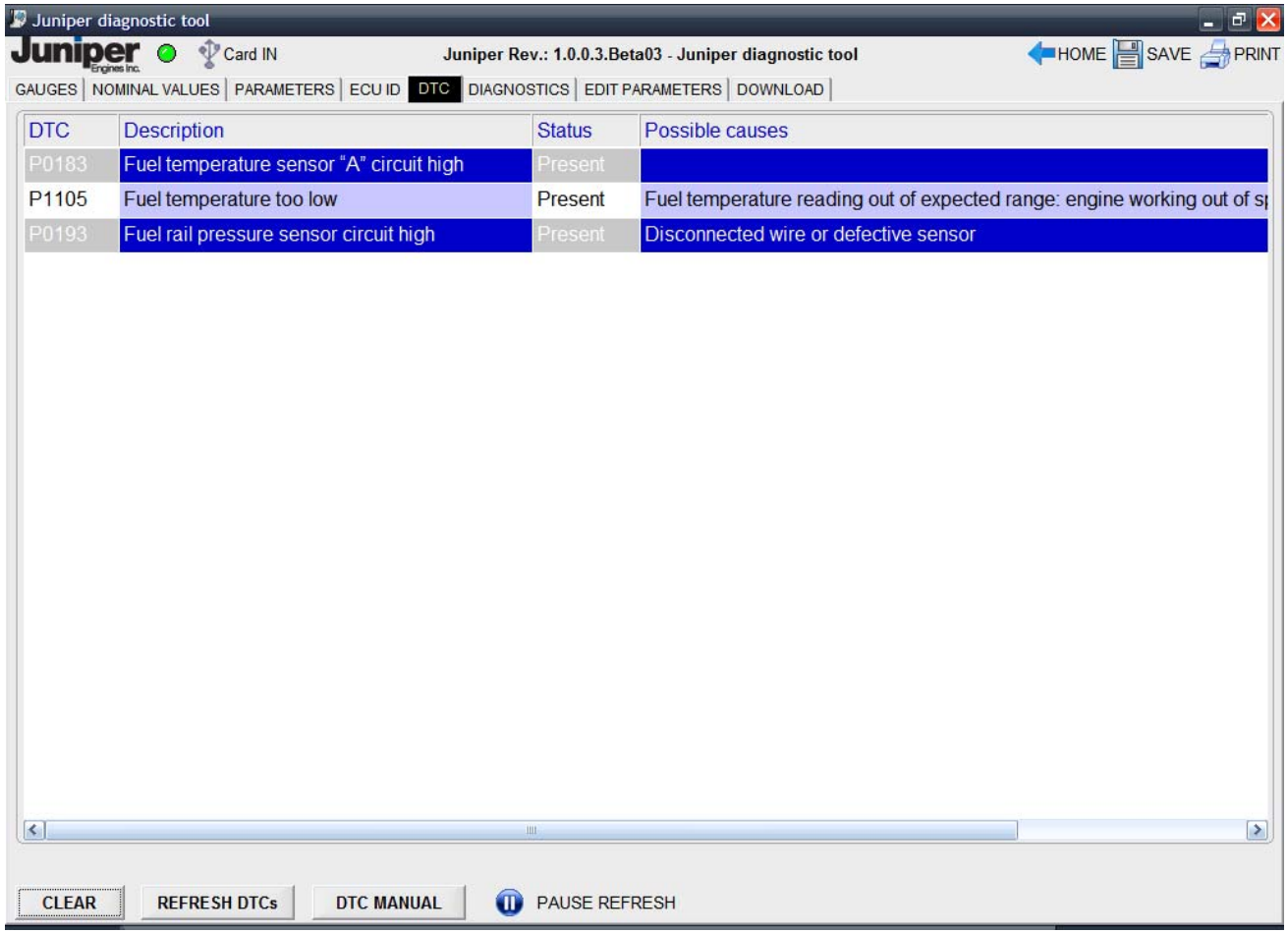
- **These are parameters that provide identification information of the ECU and vehicle**



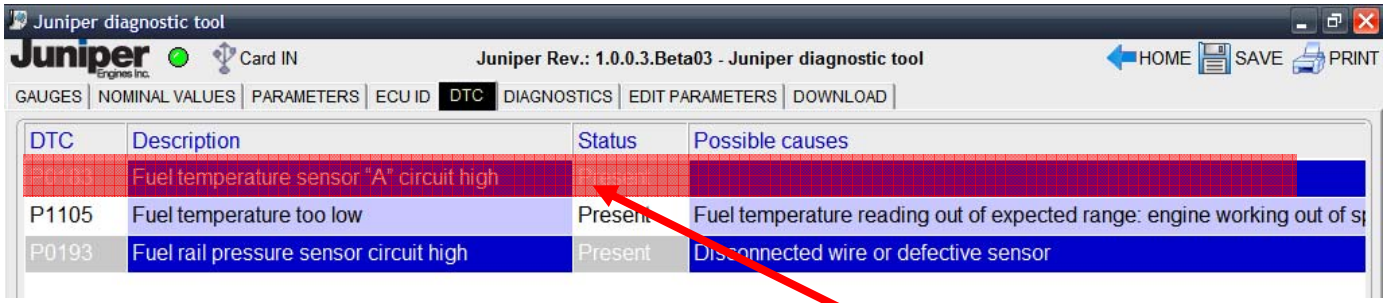
Information	Value
Hw version	ÿÿÿÿ
ECU serial number	-1
ECU production date	ÿÿÿÿÿÿ
ECU sw version	021200
Calibration version	0212
Calibration date	140510
System identifier	0
System assembly date	240310
Engine serial number	10000412345678
Calibration comments	HY24_LPGCLKS20T0HT_A
Loader version	0206
Vehicle identification number	12345678901234567
Calibration identifications	1000096
Calibration validation number	0xFFF8638C

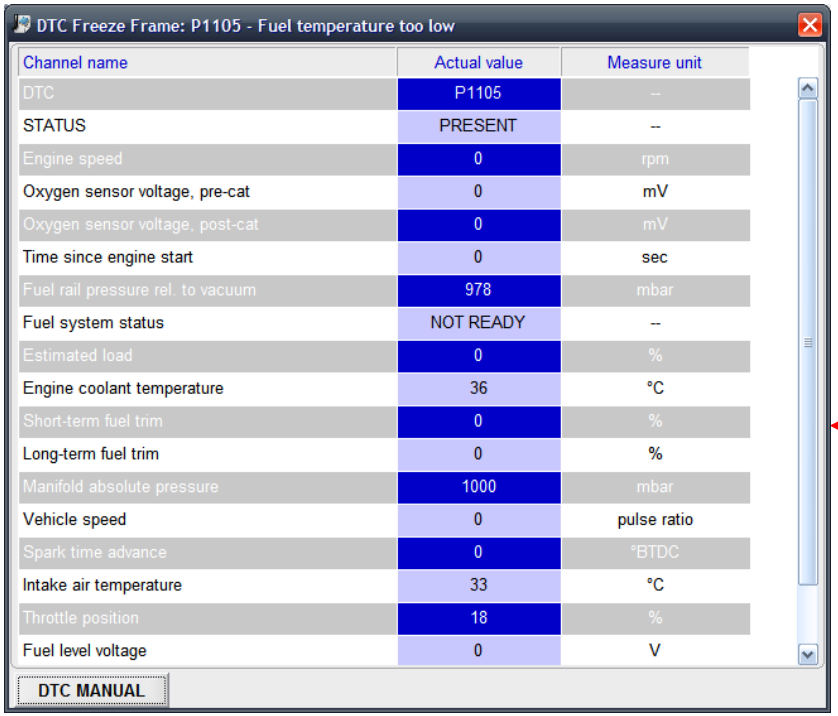
DTC Tab: Diagnostic Trouble Codes

- **Allows for viewing of the current DTCs that are present and stored on the ECU.**



DTC Tab: DTC Snapshots



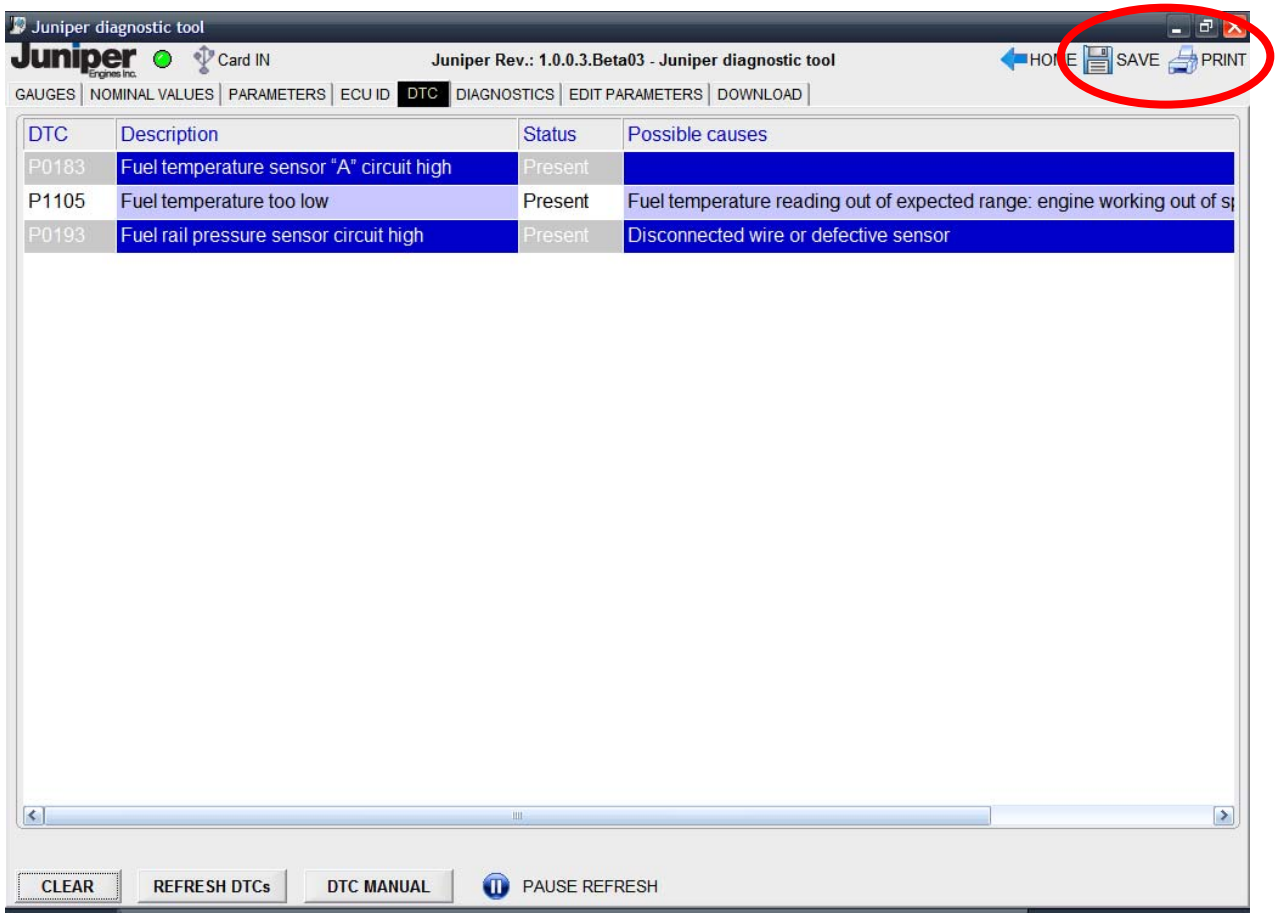


Double Click to show snapshot

DTC Snapshot

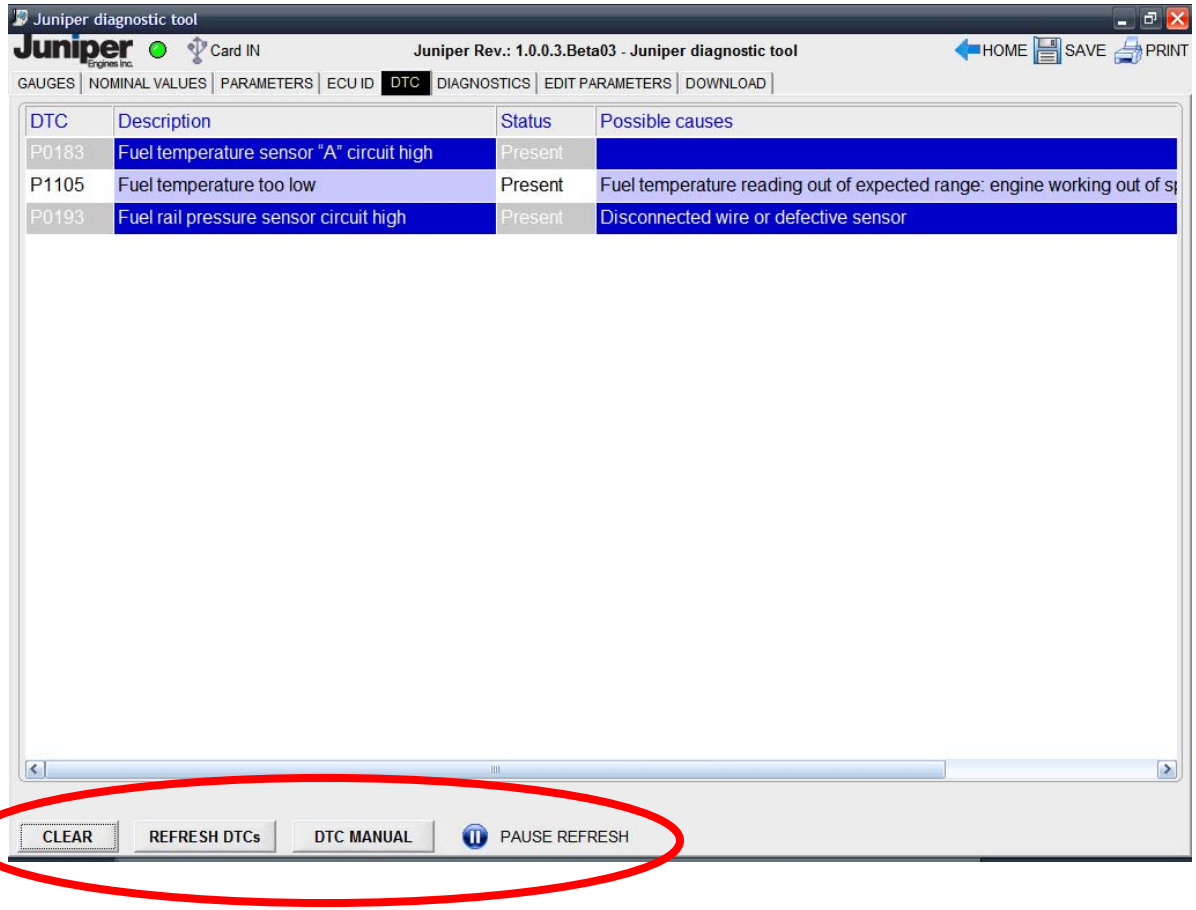
DTC Tab: Function Buttons

- **There are buttons at the top of the DTC page that allow you to save the current DTCs to a text file, and to print the DTCs directly to an attached printer**



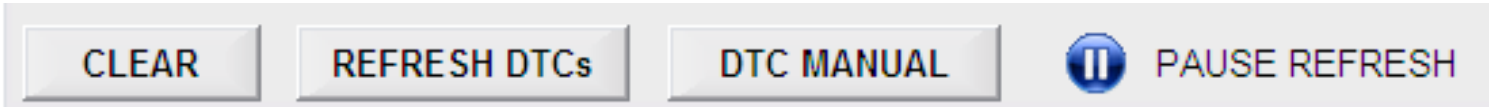
DTC Tab: DTC Function Buttons (2)

- There are buttons at the bottom of the DTC page that allow you to clear, refresh, pause automatic refresh, and pull up the DTC manual



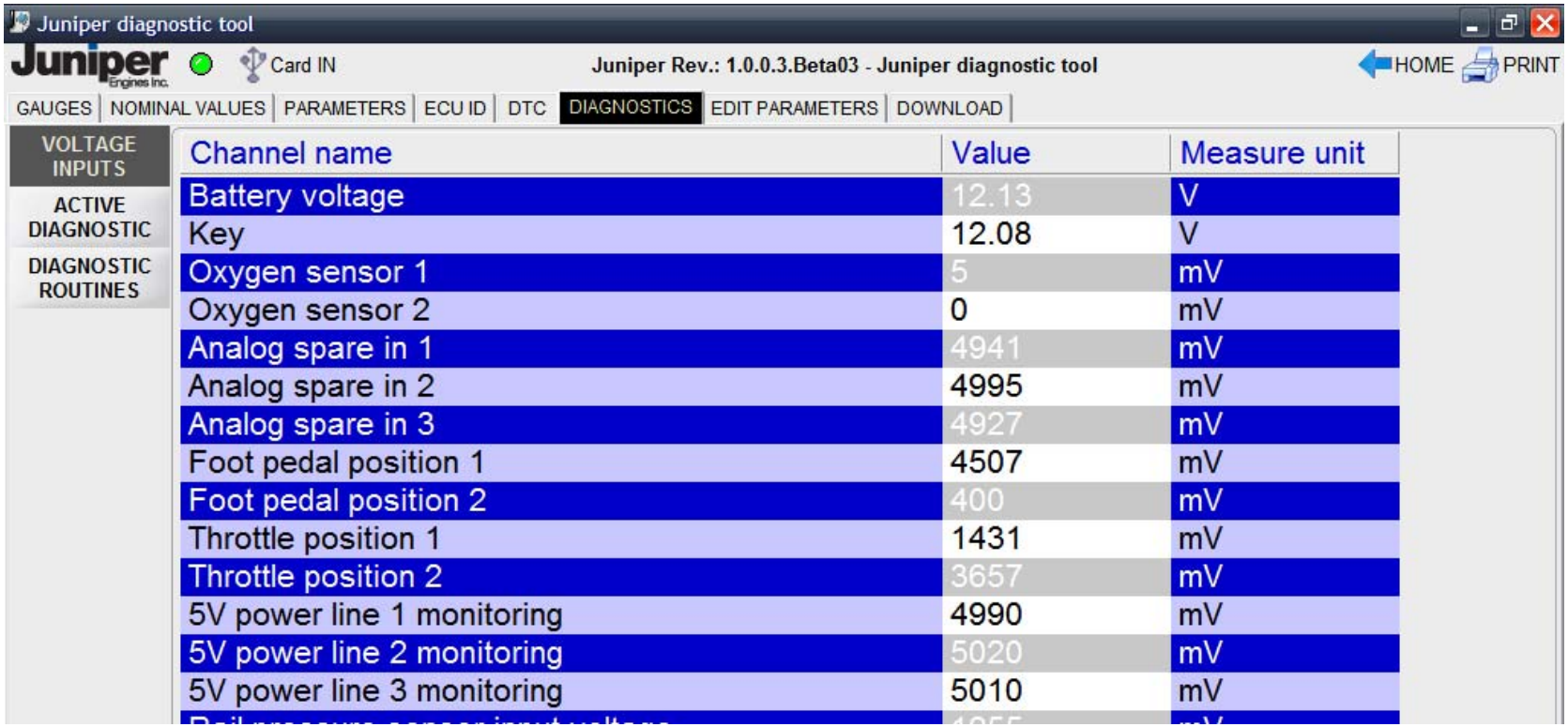
DTC Tab: DTC Function Buttons (3)

- **CLEAR**
  - Can only be activated when during key-on and when the engine is off
  - Clears all PRESENT and STORED DTCs permanently from memory of the ECU
  - Allows user to more easily determine whether a fault has been fixed
- **REFRESH DTCs**
  - Clicking on this when the ECU is connected will ensure ALL present and stored DTCs are shown on the screen
  - Keep in mind that this page automatically refreshes every 5 seconds anyway
- **DTC MANUAL**
  - This button brings up the document that describes all DTCs in detail
- **PAUSE REFRESH**
  - If the DTC buffer is full, it will automatically and repeatedly scroll to the top to show the most current DTC
  - Using this button will allow you to pause the automatic refresh so you can scroll freely



Diagnostics Tab: Diagnostic Values

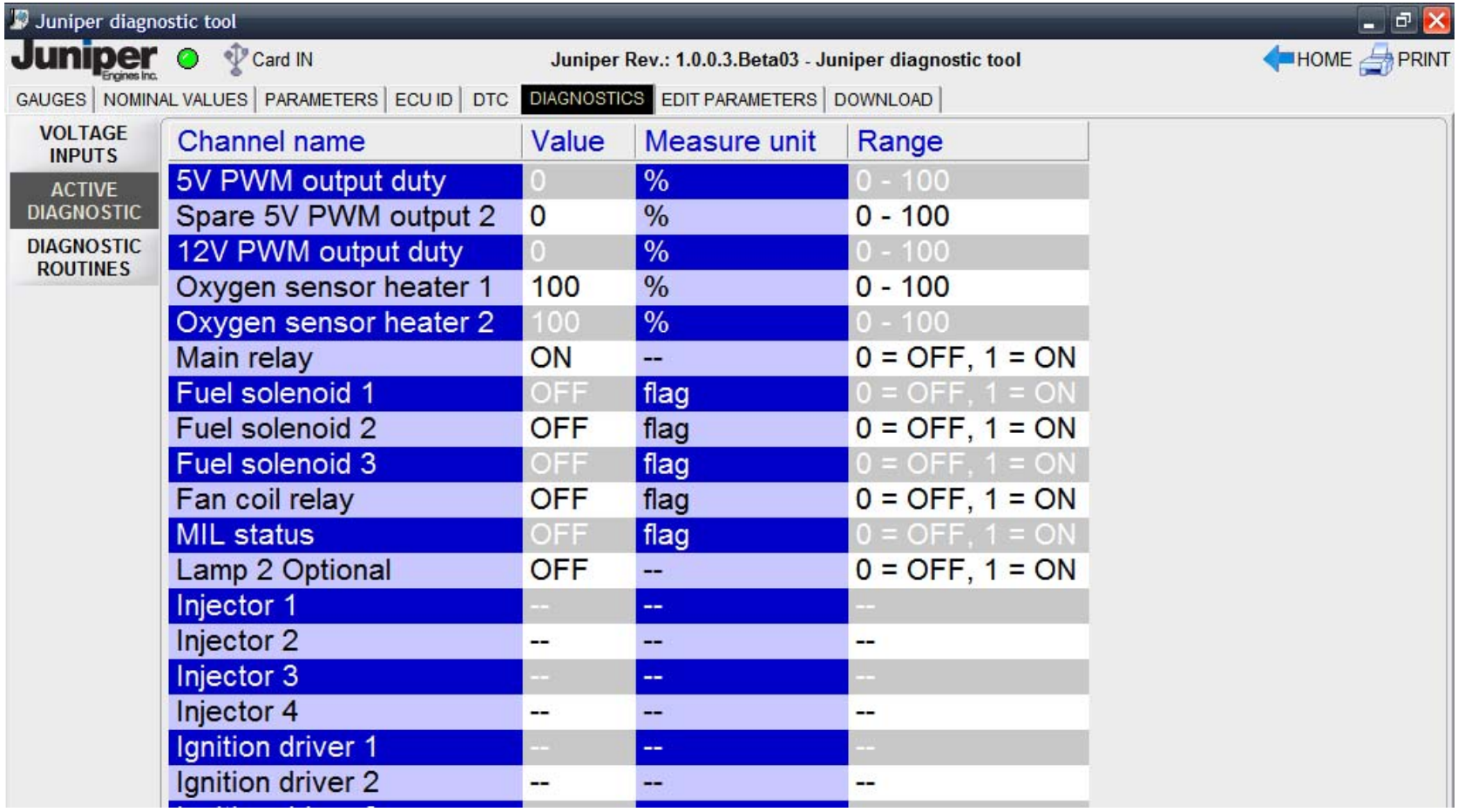
- Diagnostic values can only be accessed with key-on and when the engine is not running
- Voltage Inputs show detailed voltage inputs that are relevant to the OBD system



Channel name	Value	Measure unit
Battery voltage	12.13	V
Key	12.08	V
Oxygen sensor 1	5	mV
Oxygen sensor 2	0	mV
Analog spare in 1	4941	mV
Analog spare in 2	4995	mV
Analog spare in 3	4927	mV
Foot pedal position 1	4507	mV
Foot pedal position 2	400	mV
Throttle position 1	1431	mV
Throttle position 2	3657	mV
5V power line 1 monitoring	4990	mV
5V power line 2 monitoring	5020	mV
5V power line 3 monitoring	5010	mV

Diagnostics Tab: Active Diagnostics

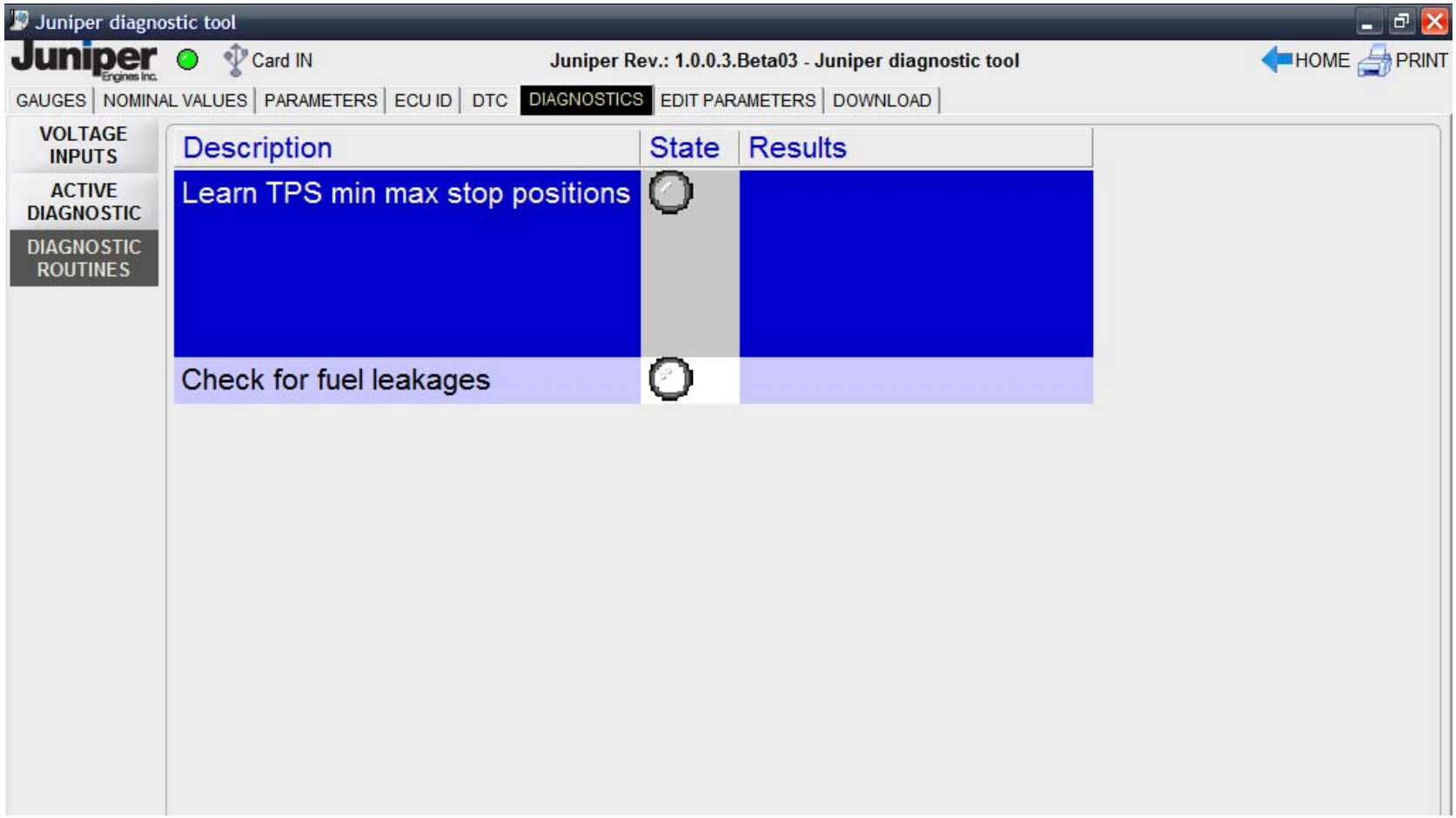
- **These allow for manual setting of various actuators for easier troubleshooting**



Channel name	Value	Measure unit	Range
5V PWM output duty	0	%	0 - 100
Spare 5V PWM output 2	0	%	0 - 100
12V PWM output duty	0	%	0 - 100
Oxygen sensor heater 1	100	%	0 - 100
Oxygen sensor heater 2	100	%	0 - 100
Main relay	ON	--	0 = OFF, 1 = ON
Fuel solenoid 1	OFF	flag	0 = OFF, 1 = ON
Fuel solenoid 2	OFF	flag	0 = OFF, 1 = ON
Fuel solenoid 3	OFF	flag	0 = OFF, 1 = ON
Fan coil relay	OFF	flag	0 = OFF, 1 = ON
MIL status	OFF	flag	0 = OFF, 1 = ON
Lamp 2 Optional	OFF	--	0 = OFF, 1 = ON
Injector 1	--	--	--
Injector 2	--	--	--
Injector 3	--	--	--
Injector 4	--	--	--
Ignition driver 1	--	--	--
Ignition driver 2	--	--	--

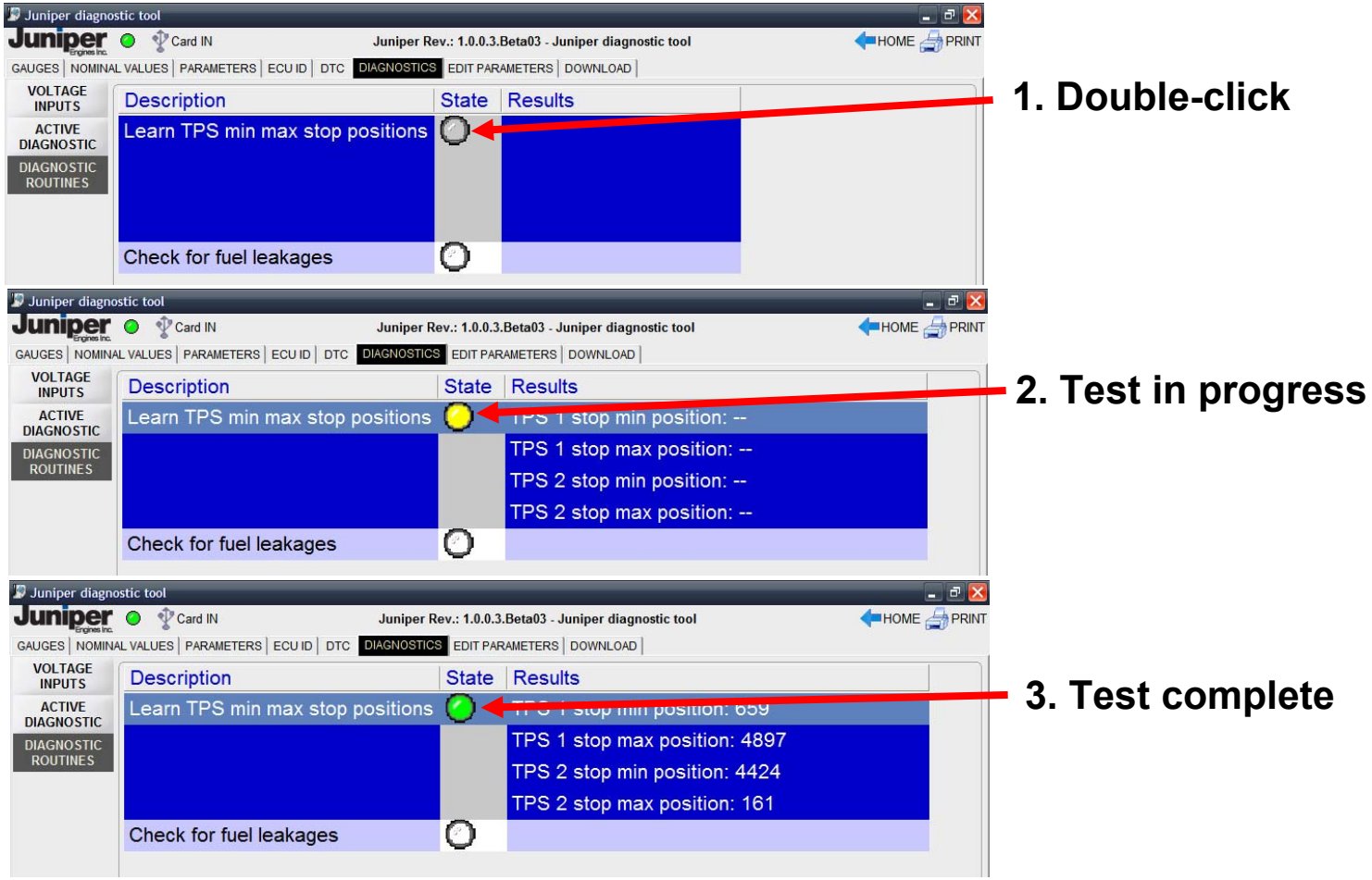
Diagnostics Tab: Diagnostic Routines

- These routines allow for throttle self-calibration, and fuel leakage checking



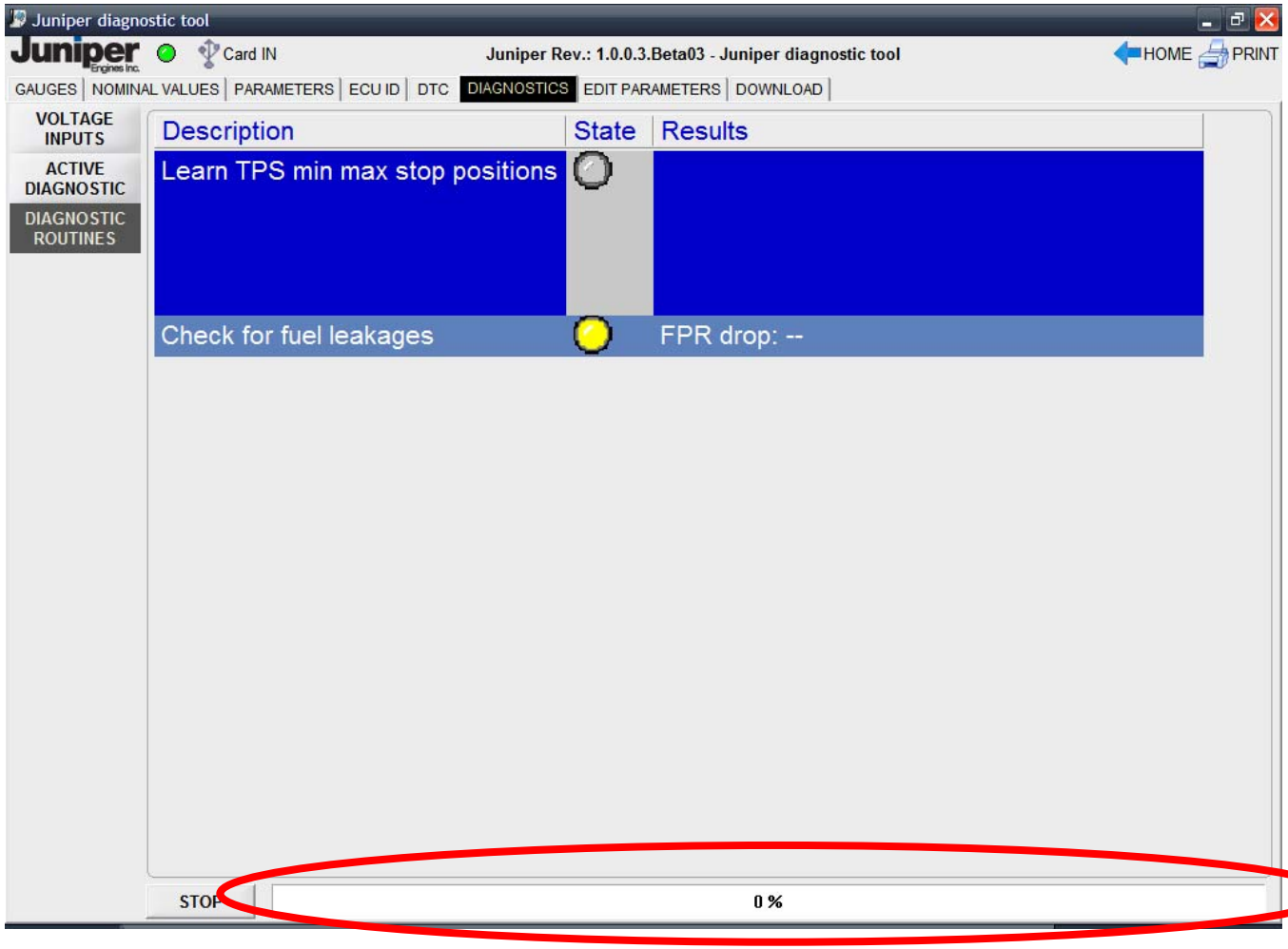
Diagnostics Tab: Diagnostic Routines (2)

- To activate diagnostic routine, double-click on circle, and program will indicate when the test is in progress, and when the test is complete


Juniper diagnostic tool
Juniper
Card IN
Juniper Rev.: 1.0.0.3.Beta03 - Juniper diagnostic tool
HOME
PRINT
GAUGES | NOMINAL VALUES | PARAMETERS | ECU ID | DTC | DIAGNOSTICS | EDIT PARAMETERS | DOWNLOAD
VOLTAGE INPUTS
ACTIVE DIAGNOSTIC
DIAGNOSTIC ROUTINES
Description
State
Results
Learn TPS min max stop positions
Check for fuel leakages
1. Double-click
TPS 1 stop min position: --
TPS 1 stop max position: --
TPS 2 stop min position: --
TPS 2 stop max position: --
2. Test in progress
TPS 1 stop min position: 659
TPS 1 stop max position: 4897
TPS 2 stop min position: 4424
TPS 2 stop max position: 161
3. Test complete

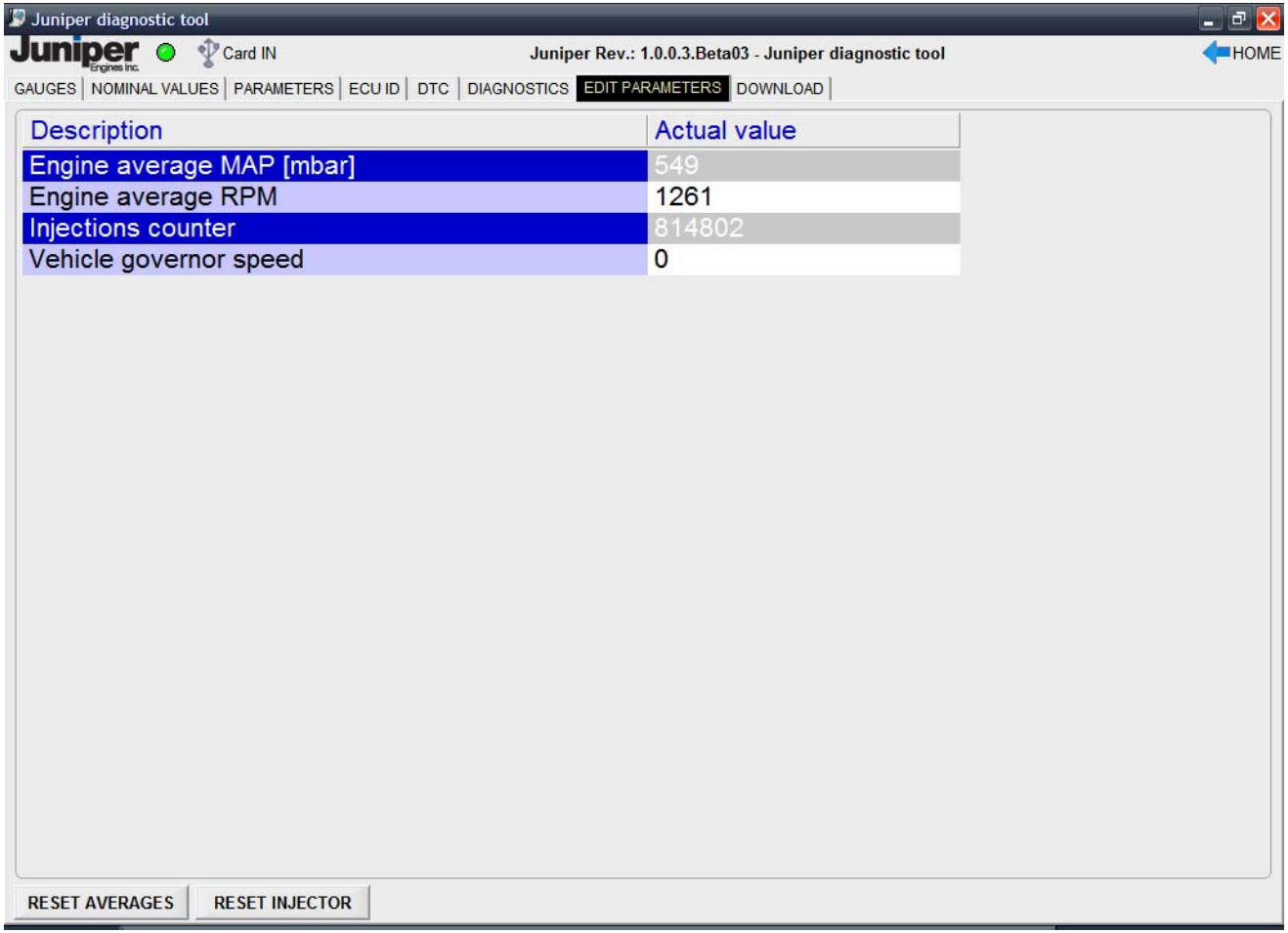
Diagnostics Tab: Diagnostic Routines (3)

- **The bottom of the page will also show whether or not a test is in progress**



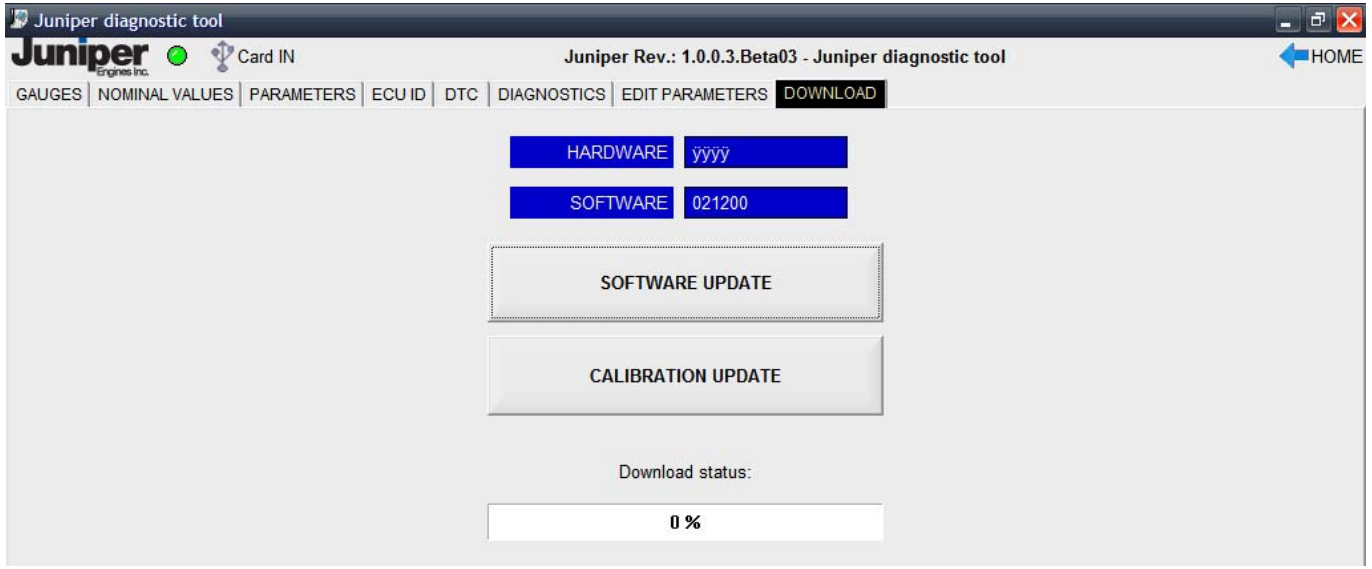
Edit Parameters Tab (Advanced)

- **This page allows for editing of ECU and vehicle identification parameters**



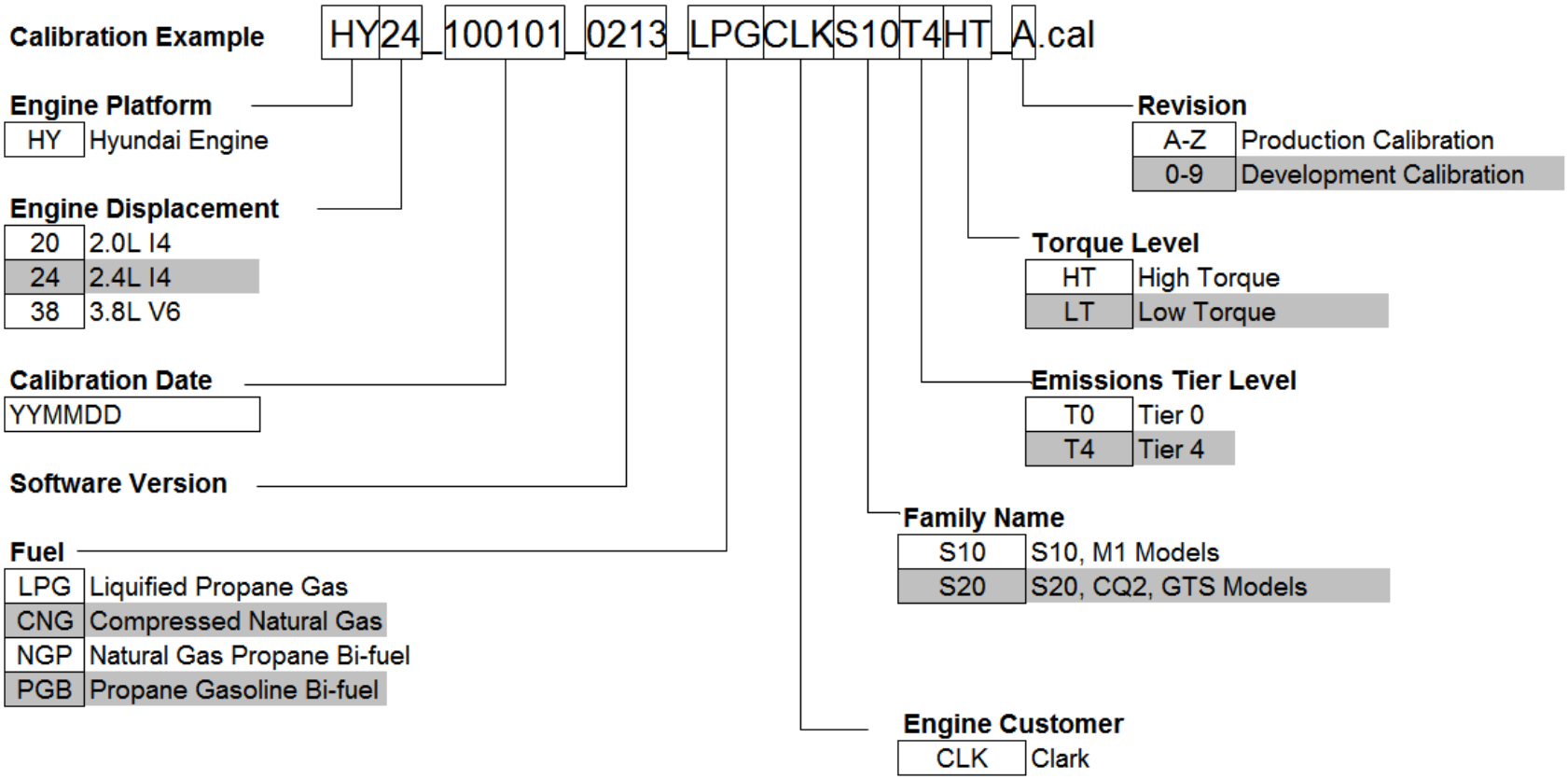
Download Tab: Calibrations and Software (Advanced)

- This page allows for updating of software and calibration
- Software files have the filename extension ".mot" and calibration files have the filename extension ".cal"
- Calibration update **MUST** be performed immediately after software update. Calibration version must **match software version**
- Key-off for at least 20 seconds after calibration update to allow for proper software updating (or key-off until program loses connection to ECU)



Calibration Naming Conventions

Juniper Calibration Naming Convention



Sample Calibration Names:

HY24_100513_0212_LPGCLKS2XT0HT_0.cal	Clark LPG GTS33 Tier 0 Calibration
HY24_100512_0212_LPGCLKS10T4LT_0.cal	Clark LPG C20cL Tier 4 Calibration